SUMMARY REPORT

OF THE

MINES BRANCH

OF THE

DEPARTMENT OF MINES

FOR THE CALENDAR YEAR ENDING DECEMBER 31

1915

PRINTED BY ORDER OF PARLIAMENT

OTTAWA
PRINTED BY J. DE L. TACHÉ, PRINTER TO THE KING'S MOST
EXCELLENT MAJESTY
1916

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To Field Marshal, His Royal Highness Prince Arthur William Patrick Albert, Duke of Connaught and of Strathearn, K.G., K.T., K.P., etc., etc., etc., Governor General and Commander in Chief of the Dominion of Canada.

May it Please Your Royal Highness,—

The undersigned has the honour to lay before Your Royal Highness, in compliance with 6–7 Edward VII, chapter 29, section 18, Summary Report of the work of the Mines Branch of the Department of Mines during the calendar year ending December 31, 1915.

(*Signed*) LOUIS CODERRE,

Minister of Mines.

Hon. Louis Coderre,
Minister of Mines,
Ottawa.

Sir,—I have the honour to submit herewith, the Director's Summary Report of the work of the Mines Branch of the Department of Mines during the calendar year ending December 31, 1915.

I am, Sir, your obedient servant,
(*Signed*) R. G. McCONNELL,
Deputy Minister.

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SUMMARY REPORT
OF THE
MINES BRANCH OF THE DEPARTMENT OF MINES
FOR THE CALENDER YEAR ENDING DECEMBER 31, 1915

R. G. McConnell, B.A.,
Deputy Minister,
Department of Mines.

Sir,—I have the honour to submit, herewith, the Summary Report of the Mines Branch of the Department of Mines, for the calendar year ending December 31, 1915.

CHANGES IN STAFF.

E. Lindeman, M.E., resigned his position, August 1, 1915, as assistant engineer in the Division of Metalliferous Deposits.
T. W. Hardy, B.Sc., resigned his position as assistant chemist in the Division of Fuels and Fuel Testing, December 1, 1915.
A. F. Purcell, resigned his position as messenger, July 15, 1915.

The following additions to the staff of the Mines Branch were made during 1915:—
Arthur Buisson, B.Sc., appointed February 16, 1915, as mining engineer in the Statistical Division.
N. B. Davis, M.A., B.Sc., appointed April 7, 1915, as clay technologist in the Ceramic Division.
C. S. Parsons, B.Sc., appointed July 22, 1915, as assistant engineer in the Ore Dressing Division.
R. T. Elworthy, B.Sc., appointed July 31, 1915, as assistant chemist in the Division of Chemistry.
L. L. Bolton, M.A., B.Sc., appointed August 1, 1915, as mining engineer, Statistical Division.
Miss Lillian McCann, appointed August 28, 1915, as clerk in the Division of Chemistry.

ORGANIZATION: CLASSIFIED LIST OF STAFF.

The following is a complete list of the technical officers and other employees at present on the staff of the Mines Branch:—

Administration Staff—
M. M. Farnham, B.A., secretary to the Mines Branch.
Miss J. Orme, private secretary.
W. Vincent, filing clerk.
G. Simpson, distribution clerk.
Miss I. McLeish, typewriter.
Miss W. Westman, typewriter.

Miss M. E. Young, typewriter.
Mrs. O. P. R. Ogilvie, librarian.
E. O'Leary, messenger.
J. H. Fortune, caretaker.

Division of Mineral Resources and Statistics—
J. McLeish, B.A., chief of division.
L. L. Bolton, M.A., B.Sc., mining engineer.
A. Buisson, B.Sc., mining engineer.
J. Casey, clerk.
Mrs. W. Sparks, clerk.
Miss G. C. MacGregor, B.A., clerk.
Miss B. Davidson.

Ore Dressing and Metallurgical Division—
G. C. Mackenzie, B.Sc., chief of division.
W. B. Timm, B.Sc., assistant engineer.
C. S. Parsons, B.Sc., assistant engineer.
H. C. Mabee, B.Sc., chemist.

Division of Fuels and Fuel Testing—
B. F. Haanel, B.Sc., chief of division.
J. Blizard, B.Sc., technical engineer.
E. S. Malloch, B.Sc., assistant engineer.
E. Stansfield, M.Sc., engineering chemist.
F. E. Carter, B.Sc., Dr. Ing., assistant chemist.
J. H. H. Nichols, M.Sc., assistant chemist.
A. Anrep, peat expert.
L. J. MacMartin, clerk.

Division of Chemistry—
F. G. Wait, M.A., chemist, chief of division.
M. F. Connor, B.A.Sc., assistant chemist.
H. A. Leverin, Ch.E., assistant chemist.
N. L. Turner, M.A., assistant chemist.
R. T. Elworthy, B.Sc., assistant chemist.

Division of Metalliferous Deposits—
A. W. G. Wilson, M.A., Ph.D., chief of division.
A. H. A. Robinson, B.A.Sc., assistant engineer.
Miss Della M. Stewart, M.A., technical typewriter.

Division of Non-metalliferous Deposits—
H. Fréchette, M.Sc., chief of division.
H. S. de Schmid, M.E., assistant engineer.
L. H. Cole, B.Sc., assistant engineer.
S. C. Ells, B.A., B.Sc., assistant engineer.

Division of Ceramics—
J. Keele, B.Sc., chief of division.
N. B. Davis, M.A., B.Sc., assistant engineer.

Division of Explosives—
J. G. S. Hudson.

Draughting Division—

H. E. Baine, chief draughtsman.
L. H. S. Pereira, assistant draughtsman.
A. Pereira, draughtsman.
E. Juneau, draughtsman.
D. Westwood, draughtsman.
W. Campion, mechanical draughtsman.

OUTSIDE SERVICE.

Miscellaneous Employment, Mines Branch—

A. W. Mantle, mechanical superintendent.
B. M. Derry, millman, ore dressing laboratory.
Thos. J. Dunn, machinist.
J. B. Robertson, chemist, fuel testing laboratory.
F. W. Burstow, machinist.
V. F. Joly, handy man and blacksmith.
Emille Chartrand, handy man and machinist.
August Kritsch, labourer.
Robert Curran, laboratory boy, ore dressing laboratory.
Walter Kritsch, laboratory boy, fuel testing laboratory.
A. Gravelle, carpenter.
F. W. Dier, electrician.
R. S. Cassidy, laboratory assistant (Sussex St.).
E. Lester, laboratory assistant, ceramic division.
A. H. Salter, packer.
J. Routhier, packer.
W. Reid, labourer.
A. Mousseau, labourer.

DOMINION OF CANADA ASSAY OFFICE, VANCOUVER.

G. Middleton, manager.
J. B. Farquhar, chief assayer.
A. Kaye, assistant assayer.
H. Freeman, assistant assayer.
D. Robinson, chief melter.
G. N. Ford, computer and bookkeeper.
T. B. Younger, clerk.
H. E. Warburton, clerk.
R. D. McLellan, general assistant.
E. F. Pritchett, janitor.

INTRODUCTORY.

During the year 1915, the Mines Branch of the Department of Mines has primarily directed its activities to investigations relative to metallic and non-metallic deposits; experimental tests of ores, metals, and fuels; examination and analyses of mineral specimens; collection of information relating to mineral resources; and the tabulation of statistics relative to the mineral production of Canada.

This work is, necessarily, for the most part, a continuation of the programme carried out in previous years, since it is impossible, owing to the nature and magnitude of the several investigations, to complete in any one season the whole of the work outlined.

In addition to the general programme outlined above, the Mines Branch has continued several special investigations, instituted in former years, mention of which is to be found in previous reports of the Department. Reference is made to the work being done in connexion with exploration of the bituminous sand area of North Alberta; which included, during the present year, the laying of an experimental pavement with bituminous sand in the city of Edmonton.

The investigation of the Building and Ornamental Stones of Canada was continued; activities being confined to the Western Provinces of Saskatchewan and Alberta.

The examination of mineral waters, inaugurated during the previous season, has received attention, several samples having been collected and subjected to the required laboratory tests, to determine, especially, their radioactive properties.

Mine operators have taken advantage of the privilege extended by the Mines Branch to have analyses made of mine air; and, as a consequence, several hundred samples have been received and reported upon.

Mention might be made of the Department's action with regard to assisting the clay working industry. A fully equipped Ceramic Laboratory has been established, and a systematic investigation of the clay and shale deposits of Canada is being undertaken.

The Mines Branch has devoted no small part of its activities to giving practical assistance in various ways to the movement for placing on the market certain of our mineral products now much in demand, owing to conditions due to the war. One instance of this class of work is the assistance rendered by the Department in the examination of several molybdenite properties; the sampling and testing of molybdenite ores from different prospects; and the perfecting of a simple concentration process for these ores, in order that the product may meet the requirements necessary to make it a marketable commodity.

In succeeding parts of this report detailed references will be found concerning the specific work done by the different officers of the staff. During the year, several reports have been issued in connexion with the special investigations being conducted. In this connexion it has been the custom to issue preliminary reports as early as possible, and later on, when complete information and data have been obtained, to issue final reports.

ORE DRESSING AND METALLURGICAL LABORATORIES.

In the Ore Dressing and Metallurgical laboratories of the Mines Branch—which are equipped with the most modern machinery and apparatus—attention has been devoted during the past year to the testing of a number of Canadian ores and minerals, but principally to the concentration of molybdenite ores.

This latter work was undertaken, because it was thought the satisfactory milling of molybdenite ores would be necessary in view of the increasing production of war munitions; especially as the limited supply of tungsten would not meet the demands of the manufacturers of special steels.

FUELS AND FUEL TESTING.

The work of the Division of Fuels and Fuel Testing consisted in the continuation of the testing and detailed investigation of coals from the producing mines of western provinces; the investigation of peat bogs; and the investigation in the chemical laboratories of this division, of samples of coals, peats, oils, and mine air. This latter work was undertaken for the purpose of furnishing the coal mine operators with information pertaining to the composition of the air in the mine, so that defective ventilation might be remedied, and the serious accidents, heretofore directly traceable to gassy mines, be avoided. The results derived

from this class of work have proven to be of benefit to the mine operators, and has met with their hearty approbation. The number of mine air samples received from the various mines have become so numerous, that the appointment of a chemist, to attend solely to the work, has become imperative.

The chemical laboratories of this Division have been completely equipped with the necessary apparatus for the physical and chemical examination of the various oils used by the Departments of Militia and Defence, Naval Service, and Public Works: and the volume of work in this line, together with that of testing and examining coals for the purpose of assisting the various Government Departments in making proper specifications, and in carrying out contracts for the purchase of coal, has increased to such an extent that efforts are now being made to increase the chemical staff sufficiently to enable technical chemists to be put permanently on this class of work.

The investigation relating to the briquetting of western lignites, and the possibility of utilizing them as a source of oil, has already been begun; but the great pressure of work, and insufficient number of chemists, has rendered it impossible to carry this investigation along continuously.

CHEMICAL LABORATORIES.

The technical work of the chemical laboratories of the Mines Branch, in the interests of the mining industries of the country, is becoming increasingly important each year.

During 1915, the regular activities and investigations—which includes analyses of metalliferous ores and non-metallic minerals, and the physical examination of mineral specimens submitted—have fully occupied the attention of the staff in the different laboratories.

A beginning has been made with the systematic examination of the spring and mineral waters of the Dominion.

Owing to the limited staff of chemical experts, it has been impossible to comply, adequately, with the increasing demands of those interested in the various mining industries of the country. In most cases, expeditious tests are of prime importance; but since this involves careful laboratory attention, and sufficient help is not available, quick results are seldom given. It is necessary that additional assistance be provided, if the best results are to be obtained from this important Mines Branch division.

For the benefit of those interested in mining development, an illustrated Bulletin (No. 13, Catalogue No. 406), descriptive of the various laboratories, has been issued. Copies can be procured, on application.

DOMINION OF CANADA ASSAY OFFICE, VANCOUVER, B.C.

The business done at the Assay Office for the year ending December 31, 1915, shows an increase over that of previous years. This satisfactory condition is confirmatory evidence that the legislation enacted in January, 1913—concerning which reference has been made in the two previous Summary Reports of the Mines Branch—was a much needed reform.

The deposits made at the Assay Office came from British Columbia, Yukon Territory, Alberta, and Alaska; and their net value during 1915 was $707,051.00 in excess of that of 1914, and exceeded that of 1913 by $1,287,676.94.

During the year 1915, the deposits of gold made required 2,130 melts, 2,130 assays, assembling and remelting of the several deposits after purchase, into bars weighing about 1000 troy ounces, and assaying of the same. The net value of the gold and silver contained in the deposits was $2,736,302.31.

IRON ORE DEPOSITS.

Mr. A. H. A. Robinson and a party of assistants, during the field season of 1915, were engaged in the magnetometric surveying and mapping of Canadian ore deposits in the Port Arthur district of northwestern Ontario, and in Hastings county, eastern Ontario.

A summary of this field work is to be found on page 35.

LIMESTONES OF THE PROVINCE OF QUEBEC.

Investigation of the limestones and limestone industry in the Province of Quebec—commenced in 1914, was resumed this year by Mr. Fréchette. He spent the field season in examining outcrops and quarries, principally to the north of the St. Lawrence river, and on the island of Montreal. Representative samples of the limestones were secured, analyses of which appear on pages 40-65.

INVESTIGATION OF CERTAIN NON-METALLIC MINERALS.

As indicated in the previous report of this Branch, Mr. H. S. de Schmid, during part of the season, visited a number of properties, containing talc, feldspar, mica, etc., in order to secure up-to-date information for the Department with regard to these mineral deposits. Additional field work was undertaken in Alberta, where he investigated a reported discovery of phosphate rock, the result of this investigation being embodied in Mines Branch report No. 385.

When not on field duty, Mr. de Schmid was engaged in completing reports on feldspar and phosphate.

INVESTIGATION OF THE SAND AREAS OF THE PROVINCES OF QUEBEC AND ONTARIO.

The investigation of the sand and sandstone areas of the Province of Quebec, with a view to determining the suitability of their products for use in the building and manufacturing industries, commenced by Mr. L. H. Cole during the past year, was extended during the present field season to include the eastern part of Ontario.

As Mr. Cole was engaged for part of the year in supervising the installation of the apparatus necessary to equip a Structural Materials Laboratory in the Mines Branch building, Sussex St., the field work during his absence in connexion with the abovementioned investigation, was in charge of his assistant.

It is purposed to continue field work in Ontario during the year 1916.

INVESTIGATION OF THE BITUMINOUS SANDS OF NORTHERN ALBERTA.

During the past season, investigation of the bituminous sands of Northern Alberta has been continued under the direction of Mr. S. C. Ells.

It appears that these bituminous sands are the largest known deposits of their kind in the world. Nevertheless, until recently, practically nothing was known regarding their true economic importance.

In 1913 a brief reconnaissance of the deposits was made, during which time upwards of 250 individual outcrops were measured, and over 100 samples secured. As a result of this preliminary work, it was considered desirable that a thorough investigation of these deposits should be undertaken.

When the above work was commenced in 1913, opinion was divided as to the probable value of the bituminous sands as a paving material. During the winter of 1914, however, successful laboratory investigation furnishes encouraging results, and it was decided to make a practical test of the material by laying an experimental, or demonstration pavement.

Accordingly, in 1914, individual outcrops in the McMurray area were examined in more detial, and a large number of core samples secured and analysed

in the field. Based on these results, a trial shipment of bituminous sand was mined and prepared for transportation to Edmonton. During the winter of 1915, and in face of serious difficulties, a number of teams were employed, conveying the shipment to Athabaska. From Athabaska it was forwarded to Edmonton by rail.

In August, the shipment was used in the construction of an experimental pavement. As this was the first practical attempt to determine the value of Canadian bituminous sand as a paving material, the work attracted much attention.

SHALE DEPOSITS IN ONTARIO.

Mr. Joseph Keele has been engaged, during the past year, in an investigation of shale deposits in Ontario. The results obtained from these materials, in the laboratory, are very encouraging; and point to the fact that they can be utilized for the manufacture of several grades of clay products which are at present imported, and not made in this country.

BUILDING AND ORNAMENTAL STONES OF CANADA.

Under the direction of the Mines Branch, the investigation of the building and ornamental stones of Canada has been continued by Dr. W. A. Parks, of Toronto University.

In previous Summary Reports of the Mines Branch, mention was made of the work completed regarding this investigation: in the province of Ontario; in the Maritime provinces; and in the province of Quebec. In the 1914 Summary Report, reference was made to field work in the province of Manitoba: the investigations being made in view of the proposed report covering the three western provinces of Manitoba, Saskatchewan, and Alberta. During the present season, field work was carried on in the remaining two provinces, to acquire data for incorporation in the combined report.

Those interested in the stone-working industry have found that the information contained in the reports so far published in connexion with this investigation has been exceedingly valuable. The data furnished give the localities producing the different varieties of stones; the character and magnitude of the deposits; the suitability of the products for various purposes; together with their commercial possibilities, judged from transportation, mining, and other conditions affecting production. Mention is made of quarries which formerly were large producers but which, for various reasons were abandoned, and suggestions are given with a view to removing the cause that occasioned the operators to cease supplying the market with their product. In connexion with this investigation, there are now three volumes available for public distribution: Vol. I, consisting of parts 1 and 2, contains a systematic investigation of the building and ornamental stones of Ontario; Vol. II is descriptive of the deposits of the Maritime provinces; while Vol. III deals with the building and ornamental stones of Quebec.

The manuscript containing complete information regarding the building and ornamental stones of the western provinces is now being prepared for the press, and it is expected that the report will be ready for distribution early in 1916.

FIRE CLAYS OF SASKATCHEWAN.

Mr. N. B. Davis was engaged during the summer months in field work in Southern Saskatchewan, principally on the fire clay deposits. These deposits were traced out and carefully sampled, so as to map them in the area in which they occur, and also to give complete information as to their technology. A description of the field occurrences of the fire clays will be found on page 141.

INVESTIGATION OF PEAT BOGS.

During the field season of 1915, an examination of a number of the peat bogs in the Province of Ontario was made by Mr. A. Anrep, peat expert. The investigation had in view the determination of the extent, depth, and quality of the peat contained in the several deposits.

METALLIFEROUS MINES DIVISION.

Early in March, the services of Dr. A. W. G. Wilson were placed at the disposal of the Canadian Shell Committee, by the direction of the Minister of Mines. These duties, and matters arising therefrom, occupied the greater portion of his time for a period of about four months. In September, Dr. Wilson was in attendance at the International Engineering Congress in San Francisco, as the official representative of the Department of Mines. During the balance of the year he was engaged in various miscellaneous duties in Ottawa, including the preparation of certain reports on the Refining of Copper in Canada; on the Refining of Zinc in Canada; and on the Antimony resources of Canada.

DIVISION OF MINERAL RESOURCES AND STATISTICS.

This Division undertook the usual annual collection, compilation, and publication of statistics of the mining and metallurgical production of Canada. Six statistical reports were completed during the year, for publication, besides complete lists of smelter, mine, and quarry operators.

Mr. A. Buisson, assistant mining engineer, was appointed February 16, replacing Mr. Cosmo Cartwright, deceased. Mr. L. L. Bolton, assistant mining engineer, was appointed August 2.

Mr. McLeish, in charge of the Division, who in September, 1914, had been appointed a member of a special committee to investigate the iron industry in Canada, devoted much of his time during the year to the work of this Committee. Mr. Bolton also spent several months of the year on this work.

A preliminary report on Mineral Production in Canada during the calendar year 1915, is now in course of preparation, and will, as usual, be published about the first of March, and will be included as an appendix to this report.

While it would not be desirable to repeat here the review of the mining industry contained therein, it is apparent that the mining industry—which, during the latter part of 1913, and the greater part of 1914, was suffering stagnation and decline, because of the general financial depression which had spread throughout the country—began to revive shortly after the outbreak of war. The war has become essentially a war of materials, as well as of men; and so great has been the demand for metals and certain other mineral products, that, in many instances, the output in 1915 has exceeded that of any previous year.

Not only has war material been required, but industries have been developed to supply markets which have become cut off from former sources of supply. However, the output from clay plants and stone quarries, including all those products usually termed "Structural Materials," reflects more than ever the check that had been received in all constructional development, a condition which is likely to persist throughout the war.

CERAMIC DIVISION.

The work of the Division of Ceramics consisted in the investigation of materials used by the silicate industries in general.

Structural clay products, pottery, refractories, glass-making, and cement, are the chief of these industries. The principal part of the work at present is a systematic investigation into the clay and shale resources of the Dominion.

The equipment provided in the new Ceramic Laboratories in the Mines Branch building, Sussex St., Ottawa, enables the investigation of these materials to be much more thoroughly done than heretofore, so that the results obtained more nearly approach industrial requirements. This is the only laboratory in Canada equipped to carry on the physical tests on clays and shales; tests which are of prime importance when dealing with these materials, from an industrial standpoint.

Agricultural Tile.

The use of burned clay tile for underdrainage of arable lands is increasing steadily in Canada; and there is a considerable demand for information on clays suitable for this purpose. The Ceramic Division has already made great progress in this respect, as is shown by the attention given this subject in the bulletin on the Clay and Shale Deposits of Quebec; and there are now in our laboratory a number of clays from Ontario and the Maritime Provinces, being tested as to their suitability for field drain tile.

Laboratory Work.

Owing to the increased facilities at our disposal in the new testing laboratories, a much larger amount of work is accomplished than formerly. The scope of the investigations of the Ceramic Division is constantly increasing, so that additions to the room and staff will have to be made in order to meet the growing demand for information, not only on raw material, but also on finished products for structural uses.

A full description of the laboratories and apparatus is given on page 130.

DOMINION OF CANADA ASSAY OFFICE, VANCOUVER, B.C.

The amount of business done at the Dominion of Canada Assay Office, Vancouver, B.C., during the year ending December 31, 1915, shows a considerable increase over that of the previous year, and further substantiates the remark made in the 1914 Summary Report, that the abolition of an assaying and stamping charge of one-eighth of one per cent on the gross value of the gold and silver contained in the deposits, was a much needed reform.

There were 183,924·49 troy ounces of gold and silver deposited with the Assay Office during the year 1915, as compared with a deposit of 166,148·83 troy ounces for 1914, and 111,479·95 troy ounces for 1913; an increase over the two previous years of 17,775·66 and 72,444·54 troy ounces, respectively.

To keep abreast of the increase of business of the Assay Office during the year, it was found necessary to make certain changes and additions to the staff as follows:

R. D. McLellan, who resigned as general assistant, on September 11, 1914, was re-engaged as assayer's assistant, June 21, 1915.

H. E. Warburton left the service on October 3, 1914, being called out on military duty, but was re-engaged as clerk, June 21, 1915.

During the year 1915, deposits of gold were made requiring a total of 2,130 melts, and 2,130 assays, including the assembling and remelting of the individual deposits after purchase, into bars weighing about 1,000 troy ounces each, and the assaying of the same. The net values of the gold and silver contained in the deposits were $2,736,302.31.

The above deposits received, came from the following sources:—

Source	Number of Deposits	Weight		Net Value
		Before Melting	After Melting	
British Columbia...............	1516	96,501·19	93,109·69	$1,311,989.80
Yukon Territory...............	368	87,040·87	86,284·25	1,418,496.63
Alberta........................	6	120·08	105·70	1,925.94
Alaska.........................	11	262·35	252·04	3,889.94
	1901	183,924·49	179,751·68	2,736,302.31

Weight before melting......................	183,924·49 troy ounces.
Weight after melting........................	179,751·68 " "
Loss by melting.............................	4,172·81 " "
Loss percentage by melting..................	2·2688

TECHNICAL LIBRARY.

Many new publications of technical importance, all bearing on the work of the Mines Branch, have been added to the Library during the year 1915. Special attention has been given to securing publications of value to the Ceramic division.

Regular exchange copies of Mines Branch reports and monographs have been promptly distributed, and exchanges have been received with equal promptitude. A few of our European exchanges have been cut off on account of the war, but our American and Canadian exchanges have appreciably increased, in number and value.

The cataloguing, for 1915, included current accessions, also the final cataloguing of some older files in the library; embracing foreign and domestic geological surveys, transactions of scientific institutions, etc.

ACCESSIONS TO THE LIBRARY FOR 1915.

247 volumes have been added by purchase; 1,225 public documents have been presented by international geological surveys and cognate institutions; 318 bulletins, proceedings, and transactions have been received in exchange for the publications of the Mines Branch; and 350 volumes have been bound.

Approximate number of accessions for 1915......................2,190.

INDIVIDUAL SUMMARY REPORTS.

METALLIFEROUS DIVISION.

I

OFFICE WORK.

Alfred W. G. Wilson,
Chief of Division.

The writer's field duties and the work arising therefrom occupied the greater portion of his time between the first of April and the end of October. Near the end of March, by direction of the Minister of Mines, the writer's services were placed at the disposal of the Canadian Shell Committee for special investigations required by them. The greater portion of the next four months was spent upon this work. During the month of September the writer was in attendance at the International Engineering Congress in San Francisco as the official representative of the Department of Mines. The return journey was made through Sudbury, Ontario, and a day was spent visiting the smelting plants at Coniston and Copper Cliff. The latter part of the month of October was spent on a visit to Nova Scotia and New Brunswick, to ascertain the present condition of the antimony mining industries of these provinces.

In view of the public interest which attaches to the possibility of producing refined copper and refined zinc in Canada the writer has prepared brief preliminary reports setting forth the situation as it was in 1915. A short report on the occurrence of antimony ores in Canada has also been prepared, and is submitted herewith. It is a matter of regret that more complete details could not be supplied with this report, but these have been withheld at the request of the operators. The writer wishes, however, to take this opportunity to express his appreciation of the courtesies extended to him by the operators of the antimony mines at West Gore, Nova Scotia, and Lake George, New Brunswick, on the occasions of his visits to these properties. In both localities every facility was extended to him, to inspect the mines, and to observe the various processes in operation.

II

POSSIBILITY OF PRODUCING REFINED COPPER IN CANADA.

COPPER RESOURCES OF CANADA.

PRODUCTION OF COPPER ORES.

Native copper occurs in Canada in a number of different localities, but in no place within reach of existing lines of transport has exploration work disclosed concentrations of the metal in sufficient quantity to render it practical to operate these deposits commercially by present methods, the copper content of the rock being usually less than one per cent.

Minerals containing copper as an essential constituent occur in many places throughout Canada. Those commercially important are the sulphides; carbonates and oxides also occur, usually in association with sulphide deposits, but they are relatively of minor importance. The two sulphides, chalcopyrite and bornite, both of which also contain iron, are the most important; locally chalcocite, the pure sulphide, is also occasionally found.

At the present time copper sulphide ores are being mined successfully in the following districts in Canada:

1. **Quebec.** Eastern Townships in the vicinity of Sherbrooke, annual production varies, has been increasing in last few years, may be taken as about 5,000,000 pounds per annum. The Quebec ores are mined for their contained sulphur and are marketed chiefly in the Eastern United States; the copper recovered is in the nature of a by-product, and is recovered in United States plants after the available sulphur has been extracted.

2. **Ontario.** Sudbury district. The annual production has been increasing in recent years. In 1914 it was about 29,000,000 pounds and in 1915 it was over 39,000,000 pounds. This copper occurs in association with nickel in the pyrrhotite ores of this district. Locally the ores are smelted and treated in basic converters producing a matte which contains 80–82% of the combined metals, the balance consisting of iron and sulphur and very small quantities of other metals. The matte containing the two metals is exported to the United States and to England to refineries where the two important constituent metals, and certain included by-products are recovered separately.

3. **British Columbia.** There are three principal producing districts.

a. Kootenays, including Rossland, with a production of 3,780,000 pounds in 1914, and Nelson with a production of 586,700 pounds in 1914. In 1915, the production in this district was slightly more than 5,000,000 pounds. These are both tributary to the smelter of the Consolidated Mining and Smelting Company of Canada at Trail. The Rossland ores are essentially gold ores; they, however, contain a small amount of copper in the form of a sulphide, not much over one half of one per cent, but sufficient to make it feasible to recover the gold by the methods of the copper smelter.

b. Boundary. The production in 1914 was about 16,400,000 pounds, and in 1915 it rose to slightly less than 17,700,000 pounds. There are two smelters operating in this district, that at Grand Forks, belonging to the Granby Consolidating Mining, Smelting and Power Company, and that near Greenwood belonging to the British Columbia Copper Company. The mines and smelter belonging to this latter company were closed in August, 1914, at the beginning of the war, but re-opened near the end of July, 1915. The mines and smelter of the former company were shut down for a period of 122 days at the close of the year 1914, and afterwards re-opened in January, 1915. It appears probable that the production of this district will gradually decline, unless new deposits are discovered and opened up.

c. Coast Districts. The production of the British Columbia coast districts in 1914 was about 24,000,000 pounds, while in 1915 it was almost 34,000,000 pounds. At present there are three principal producing centres:

i. *Britannia Mines* on Howe Sound, producing ores and concentrates which are shipped to Tacoma, Washington. The normal production is 15–18 million pounds of copper per annum, but it fell below that figure in 1914. When work now under way is completed production will be in the neighbourhood of 25,000,000 pounds per annum.

ii. *Anyox*, on the Portland canal about 110 miles north of Prince Rupert, at which is located a smelter owned by the Granby Consolidated Mining, Smelting and Power Company. The present capacity of this plant is about 3,000 tons of ore per day. The blister copper pro-

duced is shipped to Laurel Hill, New Jersey, for refining. A statement as to the present production is not available, but when the capacity of the plant has been increased, as proposed, to about 4,000 tons per day, the annual production should be in the neighbourhood of 40,000,000 pounds of copper.

iii. *Texada Island* has produced a small amount of copper during the last few years, chiefly from the Marble Bay mine. In 1914 the production was 771,000 pounds, which may be considered to be about two thirds normal.

iv. *Other Localities.* A small quantity of copper has been secured, from time to time, from a number of other localities along the coast of British Columbia, or from some of the islands adjacent to that coast. Prospecting, exploration, or development work is now in progress in a number of localities and it is probable that new and important discoveries will be made from time to time. One new property east of Prince Rupert and near the main line of the Grand Trunk Pacific railway is now a regular shipper of ore to Anyox.

d. SIMILKAMEEN. Extensive explorations in the Similkameen district, not far from Princeton, have been in progress during the last four years. They have shown the existence of large bodies of low grade ores. Preparations are now being made to mine these on a large scale, and to treat them in a concentrating mill. The mill concentrates are to be shipped to the British Columbia Copper Company's smelter at Greenwood, B.C., for treatment.

4. **Yukon.** Only one copper mine of importance was operating in Yukon—the Pueblo near Whitehorse. The production from this mine during the last three years has been at the rate of about 1,700,000 pounds per annum. How much ore there is in reserve it is not possible to state. The mine was closed at the beginning of the war, but preparations are now being made to re-open it and it is probable that shipments will be resumed early in the new year. During the period it was in operation all the ore produced was shipped to Tacoma, Washington, for treatment.

Summarizing the above statements it will be noted that the annual production of copper from existing mines in Canada was in the neighbourhood of 80,000,000 pounds in 1914, a little more than one-third of this being produced in Eastern Canada, and a little less than two-thirds in British Columbia. The total copper recovered from ore produced in Canada in 1914 is estimated by Mr. McLeish, Chief Statistician of the Mines Branch, at 75,738,386 pounds. In 1913 it was 76,976,925 pounds, and in 1915 is it estimated as 102,612,486 pounds.

ORE RESERVES.

With reference to the known ore reserves, upon which future production must depend, there is little accurate information available. It has not been the custom of the operating companies to make public much information with respect to these reserves, even when they themselves possess it. The larger companies all carry exploration and development work in advance of mining and in the majority of cases know that they are assured of ample reserves to keep their present plants in operation for some years to come.

In Quebec the reserves have not been made public, but they are known to be more than enough to insure production at the present rate for more than two years.

In the Sudbury region of Ontario the known reserves are variously stated to be in excess of 100,000,000 tons of ore carrying about 2 per cent copper besides nickel. The operating companies have not made public any official figures with

respect to these reserves. An official of the Ontario Bureau of Mines places the known reserves at 71,000,000 tons.

British Columbia is at present the principal copper-producing province of Canada, copper-bearing minerals being found in numerous localities in various parts of the province. The known occurrences are too numerous to be considered individually. The principal producing districts have already been enumerated. Some of the operating companies publish statements of their ore reserves, others do not, and as a consequence it is not possible to make a definite statement as to the tonnage of ore known to be available. A rough estimate, based in part on the published information supplied by certain operating companies, and in part upon rough, and therefore possibly inaccurate, estimates of the ore reserves of other companies, indicates that the known ore deposits of this Province contain in excess of 500,000 tons of recoverable copper equal to twenty years' supply at the present rate of production. In addition to these known ore deposits, which are now being exploited, there is every reason to believe that other equally important discoveries will be made in the future, not only in British Columbia, but also in Yukon.

PRESENT METHODS OF TREATMENT.

1. *Quebec* ores are nearly all exported to the United States, where the sulphur is first utilized for the manufacture of sulphuric acid and the copper contents of the ores are afterwards recovered at other works.

2. *Ontario* ores are roasted in open heaps, or in small part in mechanically operated furnaces, to drive off a portion of the sulphur. They are then treated in blast furnaces, or reverberatories, to produce a low grade matte containing the nickel and copper. This matte is further concentrated in basic lined converters until it contains 77–82% of the combined metals. In this form about 15% of the Ontario production is shipped to Wales, and the balance to the United States for further treatment. A portion of that sent to the United States is again treated to produce the alloy called monel metal, without the separation of the copper from the nickel. The balance of that sent to the United States and all of that sent to Wales is refined by special processes, the copper and the nickel being recovered separately.

3. *British Columbia* ores are in part sold directly to United States purchasers, and in part given a partial treatment before being shipped to the United States. The smelter at Trail produces a matte containing approximately 42% copper, and a considerable amount of precious metals. This matte is at present being shipped to Tacoma, Washington, for final treatment and refining. I understand that it is the intention of the Consolidated Company to install converters at Trail and to produce Bessemer cakes. This copper will contain an unusual amount of the precious metals, owing to the nature of the Rossland ores, and it will probably be necessary to refine it on the spot. Preparations are being made with this object in view, and it is stated that the refinery will have a capacity of 15 tons of refined copper per day.

The ores from the Boundary district are treated at Grand Forks and at Greenwood, both plants using blast furnaces in which a low grade matte is produced, and afterwards treating this matte in converters to produce Bessemer cakes. The Bessemer cakes which contains 96–98% copper are shipped to United States points for refining. The plant at Greenwood was idle during the early part of the year, but has resumed operations.

The ores mined at Anyox, north of Prince Rupert, are treated in blast furnaces, the resultant matte being blown to Bessemer copper in basic converters. The copper is shipped to Laurel Hill, New Jersey, for refining. A small amount of custom ores from outlying points is also treated at Anyox.

The ores mined at Britannia are concentrated in a special plant at Britannia Beach, and are then shipped to the smelter at Tacoma for final treatment. Ore from the Marble Bay mine on Texada island, and that from the Pueblo mine in Yukon is also shipped directly to Tacoma for treatment.

4. *Summary.* The foregoing paragraphs may be summarized by stating that all the copper obtained from ores mined in Canada is recovered in refineries located outside Canada, and chiefly in the United States. About ninety per cent of the copper produced in Eastern Canada is converted into a high grade matte before shipment; about sixty-six per cent of the copper produced in British Columbia is converted into Bessemer copper before shipment, and in all about twenty-five per cent of the copper ores mined in Canada is shipped directly to United States points for metallurgical treatment.

REFINING OF COPPER IN CANADA.

GENERAL STATEMENTS.

1. **Present conditions.** Canada refines no copper at the present time. About one-half of her annual output of copper is treated in blast furnaces and afterwards in converters, and is exported in the form of Bessemer copper, containing usually 95–98% copper, a few ounces of gold and silver per ton, and some impurities; about one-third of her output is exported in the form of matte, either high grade and associated with nickel, as from the Sudbury region, or of relatively lower grade, but containing much gold and silver, as from Trail. The remainder of Canada's copper production is exported as ore to foreign smelters for treatment, some of it being concentrates and some of it untreated. The reasons why this condition exists are various and complicated. In brief it may be stated that the copper producing industry in Canada has been of slow growth, and has been prosecuted largely by foreign capital which already possessed established business connexions outside Canada. In the early days it was much cheaper to arrange for the final treatment of the Canadian product in established foreign plants, it was easier, and there were fewer capital risks.

At the present time over 80 per cent of the refinery capacity of North America is located within fifty miles of New York city, and is, therefore, in the immediate vicinity of the largest American markets and shipping ports. An important factor in determining the location of these refineries has undoubtedly been the enormous saving that has been effected by reducing to a minimum the time that capital is locked up in the refined copper in transit. Another factor determining their location in this district was the possibility of securing relatively cheap power, cheap labour, and cheap supplies of all kinds, including appliances and machinery. Moreover the freights on the raw materials and supplies would be lower than on a finished product and on supplies hauled a long distance. All the conditions which brought this about may be summarized by stating that refining could be done more cheaply and conveniently in the district where the large refineries are now located than elsewhere. Once these large refineries were established in their present location it has become increasingly difficult for new organizations to compete against them and break into the market, unless the circumstances are exceptional. Moreover the capital interested in the established refineries is also the preponderating interest, directly or indirectly, in the Canadian copper production. Under these circumstances it should not be a matter of surprise that Canada's copper is not refined at home, nor can it be expected that the conditions will be changed unless existing circumstances, altered by natural conditions or by design, become such that it will be more profitable to refine Canadian ores in Canada instead of in a foreign country.

2. **Canadian production available for a refinery.** The nickel-copper mattes produced in the Sudbury district, Ontario, present a special problem in

refining, involving the recovery not only of the copper, but also of the nickel, and therefore do not need to be considered here. That portion of Canada's copper which can tentatively be considered as available for refining in Canada is the British Columbia production.

A survey of the field shows that the British Columbia copper production may be considered as tributary to two principal localities. The production of Rossland and the Boundary country is all confined to the southeastern part of the province, and geographically, would naturally be tributary either to Trail or to a plant located elsewhere in one of the Kootenays. The balance of British Columbia production comes from points on the Pacific coast and therefore may be considered as tributary to certain points on tidewater.

Again, considering the present development of the various known copper producing mines, we find that the mines of the boundary district have probably reached their maximum production and are now on the decline. The Motherlode, the largest mine tributary to the smelter at Greenwood, is estimated to contain about two years' supply of ore; the mines at Phoenix, tributary to the smelter at Grand Forks, are credited with containing enough ore to keep the smelter working to capacity for only a few years more. The Rossland mines are stated never to have been in better condition, but the total copper content of these ores is comparatively small. Other less well known mines produce ore from time to time but their operation has been more or less spasmodic and they cannot be relied on to produce a large tonnage or to produce continuously for any length of time. Undoubtedly new ore bodies will also be discovered, prolonging the lives of existing plants in this section of the province, but the ore supplies immediately in view are such that it is extremely improbable that the annual production of copper from the Kootenays will materially increase in the near future.

On the coast we find that extensive development work has been in progress for the last three or four years, showing the existence of large ore reserves, particularly at Britannia and at Anyox. On the strength of this development preparations have been made at both localities for handling greatly increased outputs of ore. There are, in addition, a number of other smaller properties from which additional ore supplies may be expected, and in general it may be stated that the districts tributary to the coast appear to be the most promising, in regard to future development.

In 1914 the interior districts produced approximately 21,000,000 pounds of copper, while the districts tributary to the coast produced about 24,000,000 pounds. In 1915 the interior districts produced 22,700,000 pounds, against 33,980,000 pounds credited to the coastal district. It is not probable that the annual production of the interior, within the next few years, will much exceed this amount; the coast districts on the other hand give promise of at least doubling the output within the next two years.

A new district in the vicinity of Princeton, in south central British Columbia, has recently been extensively explored largely by diamond drilling and development is now underway. Plans have also been prepared for the erection of a large concentrating plant, and it is proposed to treat the concentrates in the smelter at Greenwood. It can therefore be anticipated that the production of the interior district, east of the Cascades, will for a time show a considerable increase. On the other hand, if later developments show that it is more economical to produce Bessemer copper from these ores in the vicinity of the mines, or even on the coast, this production would naturally be tributary to a coast refinery, particularly, when the direct railway to the coast, now nearing completion, is ready for traffic. The establishment of a refinery in British Columbia and its location would have an important bearing in determining the location of a new

smelting and converting plant for the treatment of the Similkameen ores, assuming that other controlling conditions are satisfied.

If the establishment of a refinery were dependent only on the assurance that an adequate supply of Bessemer copper can be produced, it may safely be stated that there is enough ore in sight to supply the copper necessary to keep a plant of at least 50 tons daily capacity (36,500,000 lbs. per annum) in operation for an indeterminate number of years, a period of time, however, which would be longer than the normal life of the plant. In reaching any conclusion as to the probable commercial feasibility of such a refinery there are a number of collateral conditions that must be considered and weighed and there are numerous conflicting interests which must be apprised and adjusted. These conditions are set forth in the succeeding sections of this report.

OPPOSING CONDITIONS.

1. **Present Ownership.** The only large Canadian controlled corporation now engaged in mining and smelting copper ores in British Columbia is the Consolidated Mining and Smelting Company of Canada, with smeltery at Trail, and mines at Rossland and elsewhere. All the other important producers of copper or copper ores are controlled by United States capital. Stating the same fact in another way, it is to be noted that only about 10% of the copper production of British Columbia is home controlled, the balance, about 90%, is foreign controlled. When the anticipated increase in production from coast points takes place, this balance will approximate 95% of the total.

2. **Existing Contracts.** Nearly all the companies which are mining copper ore in British Columbia and all the smelters which are producing blister copper have contracted for the disposal of their output. These contracts usually run about five years, and existing contracts have at least two years yet to run.

3. **Smelter Capacity.** The smelter capacity at present available on the coast is not sufficient to treat all the ores now produced there. It is reported that the smelter at Anyox is to be enlarged to a capacity of about 4,000 tons of ore per day (the present capacity is about 3,000 tons), but this will provide only for the output from Anyox and for a few smaller tributary properties. Another smelter, especially equipped to treat concentrates as well as ordinary ores of copper, would be required to treat the ores and concentrates from Britannia, and such other ores as may be available from time to time. The capacity of this smelter should be at least 500 tons per day, and provision should be made to double this capacity, if necessary. It is possible that the Company now operating the Britannia mine might consider the erection of a smelter to treat their own ores, and to produce Bessemer copper, but at present their entire output is sold under contract. The smelter at Ladysmith, now idle, is capable of treating some of the ores, but not so economically as a more modern plant specially designed for the purpose. It would probably seriously handicap the development of a coast refinery to attempt to adapt the Ladysmith smelter as it now stands to the needs of such refinery.

4. **Marketing.** One of the most difficult problems confronting a Canadian refinery would be the marketing of its products. Hitherto Canada's total consumption of copper has been about 20,000 tons per annum, slightly less than half the production of British Columbia. The greater part of this copper is imported into Canada in manufactured forms, particularly as wire, rods, and sheets. The surplus production from a Canadian refinery would have to be sold in the open market. If it is produced under natural conditions and at reasonable cost, there appears to be no reason why it could not successfully compete with copper produced elsewhere. The competition of the large purchasers in the United States and in South America would have to be faced, and even possible price-

cutting. On the other hand, there is a possibility that the cheapness of production and the geographic location of the refinery might give certain advantages which it would be very difficult to offset.

Under existing conditions eastern manufacturers who require refined copper can, or could before the war, often obtain deliveries within a week of the placing of the order. Eastern refineries often had their orders booked in advance of the refining, and as a consequence there was little capital locked up in the copper in transit.

A refinery in Western Canada, operating under existing conditions, would have the following factors to contend with:

i. Long haul to eastern market on a refined product, and therefore at a higher rate.

ii. An unusually long interval must elapse between the receipt of orders and the time of delivery—resulting in proportionally larger interest losses on copper in transit.

iii. Variety of forms in which refined copper must be delivered to suit the requirements of individual consumers of small lots, means an expensive plant for a small output.

iv. Canadian demand is chiefly for copper in manufactured forms. The demand for refined copper in ingots, wire bars, and cakes is very small.

v. Competition of foreign copper, much of which can be laid down in the eastern market more cheaply.

It therefore appears desirable that other markets than that offered by eastern America be considered. Data with respect to the requirements of these markets are not immediately available. It may be pointed out, however, that refined copper from a British Columbia coast point can be laid down in British ports, and in certain continental ports at less cost per pound than from many of the interior United States producers. The Asiatic markets for manufactured products and the Australian market are also open to a coast refinery, with corresponding low freights. It appears extremely probable that any surplus production from such a refinery could be very easily disposed of in the face of eastern competition.

I am inclined to think that it would be most profitable for a coast refinery to transform its own refined copper into manufactured products such as wire, rods, bars, sheets, and tubes. These products could be marketed as easily as the refined copper. There would be a very considerable saving in interest losses on copper in transit and a probable saving in refinery equipment.

5. **Power Problems.** The principal individual item of expense in the operation of a copper refinery is the cost of power. Hydro-electric power can be produced at a number of points on the coast of British Columbia at a cost of less than $10 per horse power year. The most desirable and convenient power sites appear to have been transferred to private hands, but most of them are neither being utilized nor developed. The tax which these holding interests are inclined to levy on *bona fide* industries requiring the power is apt to be almost prohibitive. Before a refinery could be established it will be necessary to arrange to obtain power at a reasonable figure, which should not exceed $10 per horse power year, delivered at the plant. The operating company should own and control its own plant, and there should be sufficient available power in reserve to provide for reasonable expansion, and the development of subsidiary industries.

6. **Diversity of Products.** The nature of the products from the different centres makes certain commercial adjustments difficult but not impossible.

The Bessemer copper which will be produced at the Trail smelter will contain an unusual amount of gold, so much so that it will be practically impossible to satisfactorily and safely sample it. For this reason the owners of the Trail

smelter would probably hesitate in agreeing to supply their copper to an independently controlled refinery unless special arrangements are made for its separate treatment. They have already made arrangements to install two Great Falls type copper converters, and I understand are preparing to refine their own copper on a small scale.

Again, the production of the Britannia mines, which will be about 25,000,000 pounds per annum within two years' time, is in the form of ore and concentrates. Several othér mines on the coast also produce ore and do not reduce it to matte or blister copper. As already noted a smelter would have to be provided, especially equipped to treat these products.

ORGANIZATION OF A REFINERY.

PRELIMINARY STEPS.

The organization of a Copper Refining Company in Canada will require much consideration and some educative work. At present there are four large companies operating in British Columbia, whose interests are more or less conflicting. The total Canadian output available for treatment in an electrolytic refinery is comparatively small and it is therefore very desirable that as much as possible of the copper which these companies produce be treated at one plant.

One of these companies, the Consolidated Mining and Smelting Company of Canada, operating at Trail, is largely Canadian owned and is in the best potential position to start refining, both as regards equipment and technical staff. The plants at Trail now include a blast furnace equipment and an electrolytic lead refinery. An extensive electrolytic zinc refinery is being constructed, and it is expected that it will be in operation early in the new year. Two basic converters, Great Falls type, are being provided for the production of Bessemer copper. Under the circumstances it was a comparatively easy matter for this Company to arrange to refine their own copper. It will be possible to commence operations on a very small scale, and to expand as the circumstances require. There need be no serious increase in the present overhead charges, and the necessary capital expenditure will not have to be very great. Power costs will probably be comparatively high, about $20 per H.P. year, and the location of the plant is not favourable to cheap freights for incoming supplies and outgoing products. A refinery at Trail would naturally receive copper from the smelter at Grand Forks, including a rail haul of about 88 miles. Any copper produced at Greenwood might also easily be sent to Trail, the rail haul being 103 miles. Existing business arrangements and other economic conditions may, however, prevent any of this copper from the Boundary district reaching a refinery at Trail.

On the other hand not only is the amount of copper that will be tributary to the plant at Trail small, but the copper produced from the Rossland ores contains unusually large amounts of gold, seemingly somewhat irregularly distributed through the cakes, and I am informed that experience has shown that it is practically impossible to sample copper of this character satisfactorily without excessive expense. Therefore it is to be expected that while Trail will be able to produce refined copper from the products of its own plant, or from any Bessemer or blister copper that may be sent to it for treatment, it is natural to infer that they will not be willing to co-operate in the establishment of a refinery elsewhere, unless they can obtain specially favourable terms for the treatment of their own copper, or be guaranteed its separate treatment.

The companies operating at Grand Forks and Greenwood, which points, as already noted, are naturally tributary to Trail, would undoubtedly be willing to contribute their copper to some other point than Trail, the only questions involved being commercial ones.

The two principal producers on the Pacific coast of British Columbia are the Granby Consolidated Mining, Smelting and Power Company, with smelting works and mines located 110 miles north of Prince Rupert, and the Britannia Mining and Smelting Company, with mines near Britannia Beach on Howe Sound, about 30 miles north from Vancouver. If the interest and co-operation of these two corporations could be secured the success of such a project would be assured. Without the co-operation of both these producers the amount of copper available would be too small to warrant the establishment of a refinery on the coast. Both companies have existing contracts which will have to be completed before they are free to accept new obligations and these contracts have several years to run. Both would probably be willing to enter into new contracts with a Canadian refinery, but strictly on a commercial basis—that is the Canadian refinery must at least give them as favourable terms as they now receive, or are offered when renewing contracts.

The Canada Copper Corporation, which now controls the interests of the British Columbia Copper Company, and which has been developing the new deposits in the vicinity of Princeton, B. C., is controlled in the United States. At present a small amount of copper is produced at the Greenwood plant from Boundary ores, and is shipped to a United States refinery under contract. Plans are under way for the erection of a concentrating plant to treat the ores from the mines near Princeton. The concentrates at this plant are to be sent to the smelter at Greenwood, and it is to be presumed that the copper from this ore will also be shipped to the United States for refining.

Location.

1. *General.*—The following points have been considered in an attempt to reach some conclusion as to the best location for a Canadian copper refinery:—

a. A St. Lawrence point, Quebec.
b. Sault Ste. Marie, Ontario.
c. Port Arthur, Ontario.
d. Trail, British Columbia.
e. Two Pacific coast points, British Columbia.

The following are the principal factors that have been considered in each case:—

a. Relation to sources of supplies of blister copper.
b. Relation to probable markets for refined copper.
c. Relation to sources of materials for construction and maintenance.
d. Probable freights inward and outward.
e. Power costs.
f. Fuels and other supplies.
g. Labour costs.
h. Interest losses on copper in transit.

My conclusion is that British Columbia offers the best locations for the refining of the copper at present available for treatment. With respect to the location of a refinery on the Pacific coast as opposed to one at Trail I consider that the coast unquestionably offers the best sites for a commercial refinery.

The coast production will, in a few years' time, be at least ten times that of Trail, apart from the copper which might be sent to Trail from the two interior smelters. These smelters, however, could also contribute to a coast refinery, and therefore their production does not need to be specially considered when weighing the comparative merits of locating at Trail, or at a coastal point. Trail would have lower capital and overhead charges to meet than a coastal point, but the power costs, fuel costs, and labour costs would be higher, as would freights on supplies and products.

Almost any coastal point accessible to one of the trans-continental railroads is favourably located with respect to freight rates on raw materials and finished products, and has, moreover, an enormous tributary area with low freight charges. Certain points offer particularly low power costs, and cheap oil fuels are available. Inasmuch as eastern manufacturers in Canada would require not more than half the output of such a refinery, even if they were equipped to handle such a quantity, the balance would have to find another market. The potential possibilities of the British, Asiatic and Australian markets are such that the available surplus could probably be placed in these markets more cheaply from the British Columbia coast than from any other point in Canada.

In brief I consider that marketing conditions alone render it inadvisable to locate a refinery anywhere in eastern Canada for the primary purpose of refining British Columbia copper, and I consider that certain Pacific coast points would afford the best location.

2. *Selection of a site.*—Since it is assumed that if a copper refinery were to be established on the coast it would be operated as a commercial enterprise, the site selected should be chosen only on its merits. Primarily it should be on tide water, and hydro-electric power should be available. The amount of power should be much in excess of the immediate requirements to allow for expansion, and the development of certain related manufacturing industries if these appear desirable. The site, moreover, should be centrally located to facilitate the assembling of the products of the different contributing centres, and should be where climatic conditions are most favourable.

Equipment Required.

1. *Power site.*—A suitable site for the development of hydro-electric power will be required. This should be capable of supplying not less than 5,000 horse power per day, on 24 hour service. This is much in excess of the power required for a 50 ton refinery alone, but scarcely allows for reasonable expansion. There are a number of power sites available where about 20,000 horse-power could be secured and developed at a cost not exceeding $100 per developed horse-power. At the start it would not be necessary to develop the whole of such a power.

2. *Refinery and auxiliary equipment.*—A complete refinery will include the following equipment:—

1. Office building.
2. Chemical and assay laboratories.
3. Physical testing laboratory.
4. Water supply system.
5. Power plant.
    - a. Coal bins and equipment.
    - b. Fuel oil tanks and equipment.
    - c. Boiler room and equipment.
    - d. Engine room and equipment.
    - e. Generator room, transformers, motors, switchboards and equipment.
6. Furnace building.
    - a. Cranes and charging machine.
    - b. Small water-jacketed blast furnace.
    - c. Anode furnaces.
    - d. Kathode furnaces.
    - e. Casting machines.
    - f. Cast iron and cast copper moulds for anodes, wire bars, ingots, and cakes.

g. Moulds for making casting machine moulds.
h. Charcoal storage.

7. Tank house and equipment.
8. Precious metal refinery and equipment.
9. Copper sulphate plant.
10. Supply storage for furnace department, and for tank house.
11. Copper storage, incoming and outgoing.
12. Sampling shop and drills.
13. Scale house.
14. Repair shops.
    a. Forge and blacksmith shop.
    b. Foundry.
    c. Boiler shop.
    d. Machine shop.
    e. Carpenter shop.
    f. Paint shop.
15. Shop supply storage:
16. Yard, tracks, haulage motors, cars, trucks, and other yard equipment.

3. *Smeltery.*—If a smelter is established to treat the tonnage of ore for which there is no present provision, the additional equipment needed will depend upon the character of the ores available and their quantity. One or more reverberatory furnaces, and one or more basic lined converters will be required. It is also possible that a blast furnace would be needed though this is not essential. The offices, laboratories, shops, and storage warehouses provided for the refinery would also serve for the smeltery, except that they would have to be made slightly larger.

4. *Docks and Equipment.*—Docks capable of affording wharfage to at least two vessels, of about 7,000 tons capacity, would be required. They should be equipped for unloading ores, concentrates, unrefined copper in cakes and bars, and supplies as expeditiously as possible. They would also have to be equipped for loading the products of the refinery. The initial cost would vary with the location, and with the size of the plant.

5. *Subsidiary Industries.*—The establishment of subsidiary industries in close connexion with the copper refinery is worthy of consideration. The primary products of such a works would be copper wire or bars, plates and tubes. With the production of electrolytic zinc, which is a possibility of the future, it would be possible also to produce brass either in ingots or in manufactured forms.

6. *Working Capital.*—It is not possible, at the present time, to arrive at any satisfactory estimate as to the amount of capital required, either for the establishment of such a works or for their operation. The exceptional circumstances attendant on the marketing of the products of a refinery located in British Columbia may render it necessary to have a very much larger working capital than is usually required.

Copper refiners as a rule do not purchase the copper treated at their works. They usually levy a fixed treatment charge, and make a percentage deduction from the weight of the crude copper received to compensate losses in treatment. This fixed charge varies with the nature of the product to be treated from $10 to about $20 per ton. They also pay for the gold and silver recovered at current market rates. In the eastern refineries the copper in transit is rarely tied up for more than a week or ten days, exclusive of time consumed in transportation. In a refinery on the British Columbia coast it is probable that the copper in transit through the works and en route to market would be tied up for at least a month, and possibly for two months or more. It seems probable, therefore, that there would never be less than 3,000,000 pounds of copper locked up, and very fre-

quently the amount in transit would be double this quantity. At an average market value of 12 cents per pound this means the loss of interest on a sum of money lying between $350,000 and $750,000, according to the circumstances. Since nearly all the available copper ore, mattes, and converter copper also contain small quantities of gold and silver, the value of these metals, when in transit through the works, would also have to be considered. Their probable value cannot be readily estimated without an accurate knowledge of the products to be treated in the plant. The length of time these metals would be locked up would probably not be less than two weeks, and never more than four.

It is thus apparent that the circumstances of location and marketing may entail a somewhat larger interest loss on metals in transit than would normally occur, and compensatory adjustments for this extra charge would probably have to be made by the refinery.

GENERAL CONCLUSIONS.

The author's conclusions may be very briefly stated as follows:—

1. The province of British Columbia is the only province which produces enough copper annually, to support an electrolytic copper refinery.

2. Within a very short period of time the total amount of copper produced from districts tributary to the Pacific coast of British Columbia will probably be more than half the total production of Canada, and will be much in excess of that tributary to interior points.

3. For various reasons, which have been cited, the author concludes that the Pacific coast of British Columbia offers the best choice of sites for a refinery.

4. The Canadian consumer does not demand refined copper in any quantity, but purchases copper in manufactured forms; therefore refined copper produced in Canada would for the most part be unsaleable unless provision is also made for its conversion into manufactured forms, particularly bars, rods, wire, sheets and tubes.

5. A market for the surplus copper would have to be obtained. It is probable that refined copper could be marketed in Europe as cheaply as from a refinery in the eastern United States. It is also possible that the Australian and the Asiatic markets might require the surplus material if converted into manufactured products.

6. There appears to be an opening for the organization of a very considerable commercial enterprise which might include, among its activities, any or all of the following principal departments:—

a. Copper smelter (treating about 500 tons of ore per day).
b. Copper refinery (producing about 50 tons of copper daily).
c. Zinc refinery (producing about 40 tons of zinc daily, including zinc in oxide).
d. Brass making plant.
e. Rolling mills (for copper, zinc, and brass).
f. Bar and wire mill.
g. Tube mill.

7. The organization of any considerable commercial enterprise founded on the copper productive capacity of British Columbia, either to produce refined copper alone, or to carry on any or all of the associated industries here suggested, is a matter for private enterprise. The successful operation of a refinery is dependent upon the securing of contracts for refining the greater portion of the output of the productive properties tributary to the coast districts of British Columbia. The majority of the producers in these districts have already well established business connexions in various quarters and it is not to be expected that they will be willing to enter into new agreements unless reasonable proposals are made to them which it will be to their material advantage to accept.

III

MINING OF ANTIMONY ORES IN CANADA.

The principal source of the antimony obtained in Canada is the mineral stibnite, with which, in some localities, is associated native antimony. Pure stibnite contains 71·4% metallic antimony, and 28·6% sulphur. In past years metallic antimony has been recovered as a by-product from the lead refinery at Trail, being derived from antimonial lead ores of southern British Columbia.

Antimony ores, as mined in Canada, contain from 1% to 20% metallic antimony; but occasionally, small lots are secured in which the metallic content is greater. Native antimony has been reported from six Canadian localities, and stibnite from seventeen, of which eight are in British Columbia.[1] It is probable that a revision of the list will include many additional localities, especially in British Columbia.

At the present time there are only five places, so far as I can ascertain, where mining has been carried on purposely to recover antimony ores. In two of these the product is auriferous or argentiferous, and is of value not only for the antimony, but also for the precious metal content. These localities are: West Gore, Hants County, Nova Scotia; Lake George, Prince William Parish, York County, New Brunswick; lot 56, range I, Township of South Ham, Wolfe County, Quebec; Bridge River District, British Columbia; and Wheaton River District, Yukon.

Antimonial lead ores have been produced from a number of mines in the Kootenay district of British Columbia. Similar ores are also reported from northern British Columbia, in the district of which Hazelton is the business centre. No antimony is being recovered from these ores at the present time.

WEST GORE, NOVA SCOTIA.

The mine at West Gore, Nova Scotia, now belongs to the West Gore Antimony Company, the principal stockholders of this company being closely associated with the ownership of the St. Helen's Smelting Company, of Manchester, England.

The first discovery of antimony ore in this locality was made during some road building operations many years ago. The first mining was done in 1884, the property being then known as the Rawdon mine. Operations were continued for a number of years, the production gradually diminishing until 1891 when it stopped altogether. The mine was re-opened in the autumn of 1898 and operated for a short time, closing again in the spring of 1900.

It was again re-opened in January, 1903, a new plant was installed, and mining operations and development was carried on vigorously for a number of years. In 1907 a concentrating mill with a capacity of 100 tons of ore per day was erected, but appears to have been operated only a short time. The mine was closed down early in 1908 owing to litigation.

The present owners of the West Gore property came into possession about six years ago, but operations were not resumed until October, 1914. Ore shipments were resumed in December, and since that date have been gradually increasing. The present rate of output is about 1,200 tons of ore per month, which is treated in the concentrating mill, the shipments being in the neighbourhood of 110 tons per month of concentrates containing from 38% to 45% antimony. All concentrates are shipped to the St. Helen's smelter, Manchester, England.

These deposits occur within the Gold Bearing Series of Nova Scotia. The rock immediately associated with the ore bodies is a dark coloured, soft, somewhat

[1] A List of Canadian Mineral Occurrences, R. A. A. Johnston, Geological Survey, Memoir 74, 1915, pp. 24 and 215.

fissile slate. The ore-bodies occur as fissure veins containing stibnite, native antimony, a little pyrite, and occasionally small coatings of the oxides of antimony, kermesite and valentinite with a little associated quartz and calcite. Three veins have been discovered in the locality. The most northern one—called the Messervey and McDougall property in the report of the Nova Scotia Department of Mines, 1899—was worked only for a short time. The vein is stated to have averaged probably about 5 inches in width and to have shown considerable antimony associated with quartz and calcite. A shaft was sunk for a depth of 55 feet, following the vein which dips to the south at an angle of about 72°.[1]

The principal vein of the district, the one which has produced most of the ore, and on which work is now in progress, lies about 800 feet south of this. The general strike of the vein is about N. 46° W. magnetic, and the dip towards the southeast is about 72°.

A third vein, apparently that referred to in the report for 1899 as the "Northup" lead, occurs about 1,200 feet farther southwest. In later reports this vein is known as the Brook vein. An exploratory shaft was started prior to 1899 and a small amount of ore was secured from a vein about 4 inches in width. This shaft was subsequently re-opened in 1907, and a little more work done, but there does not appear to have been any large recovery of ore from this vein.

The principal vein was first opened up by two shafts in 1884, and most of the ore recovered during the first period of operation of the mine appears to have been removed through these shafts. The depth of these shafts was about 175 feet. The ore body is reported to have varied between 4″ and 18″ in width.

When the mine was re-opened in 1903 a third shaft was started. In 1903, No. 1, the most eastern shaft, had a depth of 430′. No. 2, the middle shaft was located about 160′ west of No. 1, and had a depth of 240′. No. 3, located 112′ west of No. 2, had a depth of 180′. The period of greatest development of the mine appears to have been between the years 1903 and 1908. The development at the end of September, 1907, is shown in the following table.[2]

No. of Level	Depth in feet	Present length in feet. East	West
1	113	122	160
2	228	44	160
3	318	182	432
4	410	342	763
5	492	290	179
6	586	18	269
7	662	57	447
8	769	124	200
Shaft	502		
Winze	332		

Levels Numbers 6, 7, and 8 are reached from the winze which lies 257′ east of the shaft. The shaft now in use is vertical for the first 200 feet, and then slopes to the south at an angle of about 70°, following the inclination of the vein.

As previously noted the mine was closed down early in 1908 and little additional development work can have been done. Since it was re-opened in December, 1914, a certain amount of new development work has been under way, but the principal work has been the recovery of ore already developed.

[1] N. S. Dept. Mines Report, 1899, p. 57.
[2] Report of the Department of Mines, Nova Scotia, 1907, p. 106.

At the present time active mining is going on at a number of points on the four lower levels, and a small amount of ore is also being recovered from some of the old workings on the third level.

The main ore body varies in width from a minimum of almost nothing to a maximum width of about four feet. The greatest extent of any single ore vein along any one level appears to have been about 200′, though small veins of ore, presumably offshoots from the main vein, have been encountered on several levels. The depth to which the main ore shoot extends has not been determined. It has been found to pitch towards the east at an angle of approximately 50°.

The ore, as mined, consists of stibnite and native antimony, associated with a little pyrite, quartz, calcite, and fragments of the country rock.

At the present time ore mined below the fifth level has to be raised in the winze east of the shaft and trammed by hand to the main shaft. All the hoisting is done through this shaft in a skip of about one ton capacity.

The ore is delivered to a small bin near the top of the head frame, from which it is loaded into a car and trammed by hand across a trestle to the mill, which is located about 200′ north of the main shaft house.

The boiler room at the shaft house is equipped with three boilers, a 200 horse-power Barrow Combination, a 100 horse-power Babcock-Wilcox, and a 50 horse-power Matheson. The first is used on the compressor, the third on the hoist, and the second is held in reserve. There are two compressors, a small 5 drill straight line Rand, and a Blaisdale duplex steam, compound air with a capacity of about 1250 cubic feet per minute. The hoist is a Lidgerwood, 10 × 12 capable of hoisting from a depth of 1,100 feet.

The mill was designed and constructed by Mr. D. F. Haley, and was erected in 1907. A fairly complete description was published by the Nova Scotia Department of Mines in 1907,[1] and a full description of the equipment and a flow sheet of the mill is given in that report. The present flow sheet is only slightly different from the original flow sheet as given in the publication quoted above. In general it may be stated that water concentration is used. The oversize ore is hand picked, and afterwards crushed. The crushed ore and the undersize from the first screening are successively crushed, sized, and concentrated in a series of jigs followed by Wilfley tables and Frue vanners. The mill is equipped with four jigs, five Wilfley tables, and three Frue vanners. Power is supplied by a 150 horse-power return tubular boiler, Truro Foundry Company, supplying steam to a 135 horse-power Wheelock engine, cylinder 15″ × 34″. The main water supply is obtained from an artificial pond formed by a dam thrown across the hollow of the creek bed in which the Brook shaft was located, some 1,200 feet west of the mill. It is pumped from this point to a 500,000 gallon water tank located about 400 feet south of the mill. Additional water is to be secured by another dam located north of the mill on another small creek. The principal machines employed in the mill are a Farrel rock crusher, 10″ × 16″, two Dodge crushers, 8″ × 10″ and 4″ × 6″ respectively, a Huntington mill, 5′ diam., a set of rolls, 20″ × 15″, and two elevators, one 60′ and one 40′ in length. The shipping products are hand picked lump ore, jig concentrates, Wilfley concentrates, and Frue slimes.

The ore is packed in barrels and shipped to the St. Helen's smelter, Manchester, England, belonging to the principal owners of the mine.

According to the returns published by the Nova Scotia Department of Mines the output of the mine is in the neighbourhood of 1,200 tons of ore per month. This ore is concentrated in about the ratio of ten tons of ore for each ton of concentrates. The concentrates as shipped contain, on the average, about 40% of metallic antimony, or perhaps a little more. It is stated that the ore

[1] N. S. Department of Mines Report, 1907, p. 107.

also contains about one dollar's worth of gold for each per cent of antimony in the original ore. The shipment of 1,403 tons of ore in 1907 is reported to have contained 1,319 ounces of gold. In 1906 the shipments of 782·5 tons of ore, hand picked, yielded 1031·6 ounces of gold. It is to be presumed that the present yield is at about the same rate. The yield per ton of concentrates shipped will presumably be somewhat higher, as mill concentrates were not included in the 1906 shipments, and appear to have formed only a very small part of the 1907 shipments.

At the present time the output of the mine is limited by two factors, the capacity of the shaft, and the water supply for the mill. At certain seasons of the year the water supply is limited, but it is expected that the new supply to be obtained from the new pond on the creek north of the mill will be sufficient for all requirements.

The country rock is fissile, and in the immediate vicinity of the vein is often more or less crushed and shattered. On exposure to the wet mine air it exhibits a tendency to slough off. In development it is therefore necessary to timber the drifts.

In mining an overhead stoping system is employed. The ore chutes are located at about 25′ centres, and are timbered. The stopes are filled with waste rock obtained in following the vein, which is usually of a less width than the stope. The top of the filling is kept as close to the backs as possible, leaving only room to work. The ore is broken down upon the filling and partially sorted by hand from waste before being thrown down the ore chutes. From the ore chutes it is hand trammed in ordinary steel mine cars of about one ton capacity to the shaft, where it is hoisted to the surface in a one ton skip.

LAKE GEORGE, NEW BRUNSWICK.

This discovery of antimony ore was made about the year 1863 in the parish of Prince William, York county, at a point about three miles west of the St. John river and a mile and a half from Lake George. The distance to Fredericton is about 27 miles by road, and to Harvey station, on the Canadian Pacific railway, is about eleven miles. The recently completed St. John Valley railway now runs within about three miles of the property.

According to Bailey[1] "the rocks exposed in the vicinity consist of alternating beds of slate and quartzite, being part of a wide belt of such rocks traversing the central counties, and supposed to be of either Cambrian or Cambro-Silurian age." **** "The beds are very highly disturbed, and show abundant evidence of metamorphism, connected, no doubt, with the close association of the strata with masses of intrusive granite, which may be seen *in situ* within a mile of the principal deposits of ore. These latter occur in connexion with veins of milky quartz, some of which appear to be coincident with the bedding, though more commonly intersecting this at various angles. The total area over which lodes bearing antimony were found was about 350 acres, the quartz veins varying from a few inches to six feet, in which those of stibnite appeared partly in a network of fine veinlets, and partly in more considerable masses, sometimes attaining a thickness of twelve or fifteen inches. In some parts of the workings very fine specimens of native antimony were found."

The two principal veins are nearly parallel and strike approximately N. 75° W., and dip to the north at an angle of about 45–50 degrees. The ore on these veins is said to have consisted of stibnite with quartz and country rock but without calcite. A third vein, striking nearly at right angles to these and dipping towards the east at an angle of 43° was also discovered in the earlier days. This vein was characterized by the presence of calcite in the gangue, as well as quartz and

[1] G. S. C., Report 1897, New Series, Vol. X, part M, p. 30.

country rock. A fourth vein appears to have been discovered some years after the first discoveries were made. These veins subsequently received names, in accordance with their location or discoverer. These names in order were Hibbard, Prout, Moody, and Brunswick. In addition to the mineral stibnite, which occurs in all of them, native antimony was found in some of the deeper workings, and occasionally coatings of the oxysulphide kermesite, or the oxides senarmontite or cervantite were encountered in the upper workings.

Mr. Charles Robb[1] records that in 1869 three adjoining locations had been worked from time to time during the previous six or seven years. At that time there were three shafts of 90′, 200′ and 208′ in depth respectively. The second shaft, which so far as I can identify it appears to be No. 1 of the Hibbard vein, gave access to about 400 lineal feet of drifting. The third shaft, which I identify as the Lawrence shaft, located on the transverse vein, was the deepest of the three and was in operation at that time.

The first organized company to begin mining appears to have been the Lake George Mining and Smelting Company, which owned the Hibbard property. Their operations began in 1876 but ceased the following year, apparently owing to the failure of one of the principal owners of the company, who was also acting as the selling agent.

About three years later, in 1880, the Hibbard Antimony Company was formed to take over the rights of the former company. This company appears to have controlled nearly 500 acres of ground, 200 acres of which were held in fee simple, and 300 acres under a 999 year lease. The four principal ore veins of the locality were included within this territory. Mining and smelting operations were carried on with partial success for about four years. Near the principal shaft, known as Number 2, on the Hibbard vein was erected a concentrating mill employing crushers, rolls, four jigs and one Rittinger table. The smeltery included five reverberatory roasting furnaces with condensing chambers for recovering the antimony oxides, and one reverberatory furnace for making regulus. The Hibbard Company ceased operations in 1884.

The Brunswick Antimony Company appears to have been operating the Brunswick vein at about the time the Hibbard Company was working on the Hibbard and Prout veins. I have been unable to ascertain when this company began operations. They owned a smelter at Medford, Massachusetts, where they produced metallic antimony for the purpose of making babbit metals.

In 1885 the affairs of the Hibbard Company were taken over by the Brunswick Company. The control of this corporation appears to have lain in the hands of a Mr. James and a Captain Adams, both citizens of the United States. The latter is probably the Captain Adams who was associated with the early developments in the Copper Mining Districts of Quebec, who operated the old Hartford mine, now the Eustis, between the years 1866 and 1871, and who built the first copper smelter in Quebec in 1869. For the next two years ores from both the Hibbard and Brunswick veins were shipped to the plant at Medford, but operations ceased in 1886.

During the next year or so the Hibbard vein was worked under lease for a short time, and small shipments of ore were made.

The next incorporated company to operate in the district was the Canadian Antimony Company, Limited, organized in 1907 under the laws of New Brunswick, with a capital stock of $250,000. This company took over the mines and property formerly owned by the Hibbard Antimony Company, Limited. This company is still the owner of the property, which comprises about 446 acres of freehold, a portion of which is owned by the company, and the balance held

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[1] G. S. C., Report 1866–69, p. 205.

under a perpetual lease. At the present time they also control the mining rights over an area of about 2 square miles.

This company appears to have operated the mines during the years 1907–8–9. The principal mining work was performed on the Prout vein through No. 1 shaft, and at No. 6 shaft which lies west of the main workings on the Hibbard vein, and which may be sunk on an extension of this vein, or on a parallel vein.

This company erected a complete oxide plant and a reverberatory furnace for producing metallic antimony.

Trouble seems to have arisen in the metallurgical operations and work ceased in 1909.

About midsummer of the present year the holding company granted a three years' lease, on a royalty basis, to the newly organized New Brunswick Metals Company, Limited. This company immediately took over the property and made preparations to begin active mining and the production of metallic antimony. They found it necessary to make important alterations in the oxide plant and in the reduction furnace, and active production will probably not begin until early in the new year. They hope, eventually, to reach a production of three tons of metallic antimony per day. It is proposed to initiate an extensive prospecting campaign during the winter of 1916 with a view to systematic development of the property, which is one of great promise.

The extent of the mining work on the property, at the time the present lease holders took possession, may be judged from the following description of the workings as they existed in 1907. Very little additional development work was done during 1908 and 1909.[1]

The principal veins on the property are the Hibbard and the Prout veins.

The Hibbard vein has been worked most extensively and is stated to have been traced for over one mile in length. Near the east end of the property it and the Prout vein are close together, but as one proceeds westward these veins diverge. Seven shafts have been sunk on this vein.

No. 1 Shaft. Is said to have a depth of 90 feet.

No. 2 Shaft. 875 feet west of No. 1, size 6′ × 15′ and 220′ deep. At a depth of 80′ a level is driven east 160′. About 20′ from the shaft a cross-cut has been driven 30′; farther on a winze 30′ deep has been sunk, and at 80′ from the shaft is an uprise of 20′. The vein had a thickness of three feet at this point. The western extension of this drift connects shafts numbers 2, 3 and 4, and is 320′ in length. A cross-cut from this level connects with the Prout vein at No. 1 shaft. At a depth of 130′ a level is driven east 20′ and west 30′.

No. 3 Shaft. Depth apparently 80 feet.

No. 4 Shaft. Depth apparently 80 feet, and distance from No. 2 is 320′.

No. 5 Shaft. Depth 20′, and distance from No. 4 is 280′.

No. 6 Shaft. Depth 150′, and distance from No. 5 is 1,200′. In this shaft levels were driven 160′ east and 80′ west at a point only 30′ from the surface. At 80′ from the surface levels were driven 260′ east and 200′ west. At 160′ east of the shaft a rise was put in connecting this level with the level above. This shaft has produced a good deal of ore, which is said to have contained a little sulphide of arsenic in addition to sulphide of antimony. This vein also produced some native antimony.

No. 7 or Adams Shaft. Depth 325′, and distance from No. 1 shaft 1,500′, size 6′ × 15′. Three levels are said to have been driven from this shaft, but records of their depth and length are not available.

It is to be noted that it has not been established that shafts numbers 6 and 7 are located on an extension of the Hibbard vein. They might well be on similar parallel veins.

[1] Mines Branch, Report No. 24, 1907–8, p. 613, with additional notes by the writer.

The Prout vein lies immediately south of the Hibbard vein. It has not been traced for so great a distance, but it appears to contain the best ore, so far as it has been explored.

No. 1 Shaft has a depth of 260′ on an incline of 25° to the north, measures 6′ × 15′. It is at present (1915) the only one in operation. No. 1 level at a depth of 80′ is driven east 120′ and west 160′. Much of the ore has been stoped out but a small amount still occurs on this level. No. 2 level, at a depth of 115′ extended east 50′ and west 209′ in 1907. At a distance of 100′ west of the shaft an upraise was driven connecting with No. 1 level west. No. 3 level at a depth of 200′ extended east 100′. An upraise was driven from this level to the level above at a point 50′ east of the shaft. Work was in progress on both these levels in 1915.

This shaft exposed a well defined vein carrying stibnite ore varying in width from 6″ to 3′, the average thickness being probably about 21′ of quartz and stibnite. The metallic content would be about 20% antimony.

No. 2 Shaft has a depth of 50′ and is distant from No. 1 shaft 350′. No drifting or stoping has been done. The work is said to have exposed a persistent vein of ore varying in thickness from 6″ to 3′, averaging about 20″ in thickness.

No. 3 Shaft is located 850′ west of No. 2. A record of the depth is not available. The vein on the surface has a width of about 20″.

The principal shaft in use is No. 1 on the Prout vein. This is covered with a building housing the boilers, hoist, and crushing equipment. At present ore blocked out in previous years is being stoped, crushed, hand sorted and sent to the metallurgical plant.

The metallurgical plant is housed in an adjacent building. The original plant and the metallurgical processes were described in 1909 by C. Y. Wang[1]. It has been found necessary to modify the original plant. At the request of the operators a detailed description of the plant and the method of its operation is withheld. It may be stated, however, that the system used is a modified Herrenschmidt plant in which oxides of antimony are produced by roasting the ores in a vertical type of blast furnace with coke. The oxides are collected in special cooling and condensing chambers and are subjected to a special leaching treatment to remove the arsenical oxides. The leached oxides are then dried, the surplus heat from the flues being utilized for this purpose, mixed with reducing agents, and treated in the reduction furnace.

Other veins. In addition to the two principal veins, the Hibbard and the Prout, the earlier reports mention two other veins—the Brunswick and the Moody.

The Brunswick vein was operated by the original Brunswick Antimony Company in the early eighties. Its strike is said to be parallel to that of the Hibbard vein. It lies about 250′ north of it and dips to the north. I have been unable to find any record of the amount of work done. It lies within the boundaries of the property leased by the New Brunswick Metals Company.

The Moody vein is apparently a cross vein, striking nearly at right angles to the main vein and dipping towards the east. There are said to be two shafts on this vein. So far as I have been able to identify it, this vein is the one upon which work was in progress in 1869 at the time of Mr. Charles Robb's visit to the locality. He mentions a shaft 208′ in depth, which is probably the Lawrence shaft. The other shaft has a depth of about 65′.

The mining rights over three square miles of territory, adjacent to the property of the Canadian Antimony Company, Limited, and including the property in which the old Lawrence shaft is located, are controlled by Mr. A. R. Slipp, K.C., of Fredericton, N. B., and associates.

[1] Antimony, C. Y. Wang, Chas. Griffin & Co., London, p. 83 and p. 106.

SOUTH HAM, QUEBEC.

Antimony ores were mined on lot 56, range I, township of South Ham, Quebec, many years ago. The present writer visited the locality in the summer of 1909. His report on this visit was published in the Summary Report of the Mines Branch for 1909.[1] To make this account of antimony mines in Canada complete the report is reproduced here:—

The old workings were not accessible, because the adit was blocked by clay and water, and the shafts were partly filled with snow and ice. As far as could be ascertained from a surface examination, the ore consists of metallic antimony, together with stibnite, and smaller amounts of other animony-bearing minerals. The associated rock is chloritic schist, striking nearly north-east, in which numerous lenses of quartz, usually almost black in colour, are found. In width these vary from narrow veins to lenses about 2 feet across. In the vicinity of the mine the quartz veins examined were all characterized by swells and rolls—narrowing to one-quarter of an inch, or even disappearing, or widening to 2 or 3 inches.

In the vicinity of the old mine-workings the rocks are pretty well shattered by joints, and there appears to have been a slight jostling of the joint blocks: the cavities thus formed have been filled with quartz. Such veins are very irregular in both dip and strike; presumably, some of the spaces which they now occupy were open spaces when the vein matter was introduced, because some of the quartz veins show comb structures. Originally, also, there appear to have been bands of sulphides (iron and possibly copper) between the quartz bands. In a vein 1 inch wide, six bands of quartz and five bands of red oxide of iron were noted: the latter about 25 per cent of the whole. Occasional vugs lined with quartz crystals, and containing crystals of antimony minerals, stibnite (Sb_2S_3), kermesite ($2Sb_2S_3$, Sb_2O_3), cervantite (Sb_2O_4), valentinite (Sb_2O_3) and senarmontite (Sb_2O_3) still exist. Stibnite was noted both in plate-like crystals, and in minute acicular crystals. Kermesite in small tufts of acicular crystals, and more rarely, a yellow tinted oxide probably cervantite occur. In a few instances metallic particles were found in the quartz of the veins. In the rock adjacent to the veins more abundant metallic particles were noted, and on breaking the rock a large proportion of these are seen to be distributed as thin plates along fracture planes—in some places producing a bright metallic lustre over a considerable area. Metallic minerals in thicker particles also occur scattered through the rock. The ore in the rock seems to be most abundant near the veins. In many places, through the zone supposed to be mineral bearing, no visible particles of ore could be found. In some places impregnated rock was found adjacent to a fracture in which no quartz occurs.

The strike of the structural planes of the schists lies between N. 40° E. and N. 50° E. magnetic, or, towards the ridge which lies north of the mine, and the front of which runs nearly east and west. The presence of a waste cover makes it impossible to study the area for any distance along the strike. The prospecting work has all been along the face of the hill, or nearly at right angles to the strike. Between the most easterly shaft and the most westerly one, the distance is nearly 300 yards. Prospecting pits are to be found for some distance west of the main shaft, and much costeaning has been done.

North of the shafts the hill referred to above forms a dome-like ridge about a quarter of a mile in length. It is composed of basic plutonic rock, now serpentine on the side next the schists, but consisting of a diabase on the north side. About 850 feet southeast of the east end of this ridge is another similar but smaller dome. Nearly half a mile south of the shafts—on the opposite side of a valley—lies a large area of serpentine rocks, which gradually pass into diabase farther south. The two small dome-like ridges in the immediate vicinity of the mine carry included fragments of schists in the upper surface, and they were probably forced into the schists as laccolithic masses from below. This circumstance makes it extremely probable that the band of schists has no great depth.

The mineralized area or zone lies close to the contact between the schists and the intruded serpentines. It is thus probable that other mineralized areas may occur in the same district along the line of contact. While the shape of the intruded masses makes it possible that the ore-bearing band may be of no great depth, there are no data at present obtainable from which it would be possible to determine what that depth is. On the other hand, it is also possible that the mineralized zone may follow the supposed curved surface of contact between the schists and serpentine and that a very considerable area beneath the schists may carry antimony minerals.

In 1881 there were two shafts on the property, 60 feet and 100 feet in depth, respectively, and 250 feet of drifting. Assays of the ores as they occurred in these shafts and drifts are said to have shown from 5 to 7 per cent of antimony. A small experimental plant was in operation in that year. The ore was crushed by stamps and then washed upon a broad travelling belt, the lighter particles being washed off, while the heavier were deposited at the end of the belt. This plan does not appear to have been very efficient and the losses in the tailings were high.

A number of small trial shipments were made from the property in 1881. The returns from these shipments show an antimony content of about 7 per cent. Experimental work on a Krom machine produced concentrates assaying from 30 per cent to 49 per cent antimony, in different

[1] Mines Branch, Summary Report, 1909, pp. 78–79.

experiments. In one case, what are called "extra concentrates" were obtained—assaying 53·9 per cent antimony. Concentrates on a Hastings machine assayed 37·13 per cent. The ore was found to contain about 4 ounces of silver to the ton of 2,000 pounds. No gold has been reported.

In 1886 the property was purchased by Dr. James Reed. Under his control an adit was driven into the side of the hill to cut the deeper shaft near the bottom. This adit is about 304 feet in length. A small amount of drifting was done in later years, but no information is now available as to the results obtained.

The thin plate-like character of the particles of metallic antimony, as seen on the fracture planes of the rock near the surface, undoubtedly will make concentration difficult. While the concentration experiments made on the ore from the drifts and shafts seem to have yielded a product that is commercially valuable, no data whatever are available as to the costs. Nothing can be learned about the quantity of rock handled in obtaining this ore, and the weight of the ore mined is not known. Further information is needed with respect to the underground conditions; the surface showings are not of commercial importance.

BRIDGE RIVER DISTRICT, BRITISH COLUMBIA.

No information with respect to antimony occurrences in this locality is immediately available. I understand that a small amount of stibnite was shipped during the past summer.

WHEATON RIVER DISTRICT, YUKON.

This locality is situated about 30 miles from Robinson station on the White Pass and Yukon railway. The district was studied by Dr. D. D. Cairnes, of the Geological Survey, in the summer of 1909, and the results of his work were published in 1912.[1] During the past field season (1915) Dr. Cairnes revisited the locality and a report of his more detailed study of this district will presumably appear in the Summary Report of the Geological Survey for 1915.

A good wagon road connects Robinson with the district in which these ores occur. Robinson is only 78 miles from Skagway by rail. It is therefore to be expected that if the ores of this district prove to be as valuable as is anticipated, they may be an important source of antimony in the future. At present there is no regular output, and only small trial shipments have been made.

In this locality a remarkable series of antimonial silver veins have been discovered, outcropping on both sides of the Wheaton river on Chieftain Hill and Carbon Hill.[2]

According to Dr. Cairnes:—[3]

> These antimony-silver ores occur distributed throughout a westerly-trending belt about 5 miles long by 1·5 miles wide, which includes all the southern portion of Carbon hill, and extends to the west across Wheaton river, and embraces the central portion of the eastern face of Chieftain hill. The greater number of the veins, however, have been discovered on the western face o Carbon hill, on an area about one mile in diameter. These ores occur in the Jurassic Coast Range granitic rocks, and in the Chieftain Hill andesites and volcanic breccias. The veins have, with one exception, a general westerly trend and are either perpendicular in attitude or dip to the north-east.
>
> Two of the veins are traceable for over 2,000 feet on the surface, but other outcrops are generally covered with superficial materials, so that 200 feet is the farthest that any of them have been followed, but a number probably extend much greater distances.
>
> The veins vary in thickness from 2 or 3 inches to 6 feet, but 1 to 3 feet is generally about the average of the more valuable. The fissures, in all the cases so far discovered, appear to be simple in form and without any foot or hanging-wall stringers or branching fissures.
>
> The ores consist chiefly of quartz, calcite, barite, stibnite, sphalerite, jamesonite, galena, and grey copper. Stibnite constitutes the greater part of the vein-fillings in parts of some of the veins, and in such cases is generally associated with minor amounts of sphalerite and jamesonite. Wherever any gangue is present, it is generally chiefly quartz, barite and calcite occurring only in subordinate amounts. The veins that are richest in silver consist of a quartz gangue impregnated with more or less galena and grey copper, and very few antimony minerals. In fact, the ores high in silver are generally low in antimony, and vice versa. But there are places where both antimony and silver occur together in considerable amounts.

[1] G. S. C., Memoir No. 31, Wheaton River District.
[2] Consult G. S. C., Diagram of Wheaton Map Area, No. 4, Cairnes, 1909.
[3] Loc. cit., pp. 114–115.

Assays running over 500 ounces of silver to the ton have been obtained, but they are very exceptional. Samples of the better class of ores containing galena and grey copper often carry from 100 to 200 ounces. The better grades of the stibnite ores contain 50 per cent to 65 per cent of antimony. The ores rarely contain more than a few cents per ton in gold. It is not known what the ores will average over any considerable portion of their outcrops, nor what they will assay more than 10 feet below the surface.

The zone of vein-oxidation is prevailingly shallow, and unaltered sulphides generally occur within a few inches or 4 or 5 feet of the surface. Only a slight amount of leaching appears to have taken place in these ores.

Further and more detailed descriptions of the various veins in this locality will be found in Dr. Cairnes' report.[1]

IV

INVESTIGATION OF IRON ORES.

A. H. A. Robinson.

During the summer of 1915 the magnetometric surveying and mapping of Canadian iron ore deposits, that has been carried on for a number of years by the Mines Branch, was continued throughout the season. The months of May, June, July, and August were spent in finishing the map sheets at Shabaqua and Kaministikwia, started in 1914 under the direction of Mr. E. Lindeman. Towards the end of August, at the request of the Committee on the Iron Industry, the party was moved east and a magnetometric survey made of the titaniferous magnetite deposits at and adjacent to the Orton mine in Hastings county, Ontario. After finishing at the Orton, the balance of the field season was spent in surveying and mapping deposits on lots 17 and 18, concessions I and II, in the township of Marmora.

In addition to the above, a number of trips were made from time to time during the summer to examine other iron ore occurrences in the district in which the party was working.

Mr. Howard Kennedy and Mr. J. E. O'Brien acted as assistants throughout the season and performed their duties in a highly satisfactory manner.

TOWNSHIPS OF WARE AND CONMEE.

South of Kaministikwia station, thirty miles west of Port Arthur on the Canadian Pacific railway, on both sides of the Kaministikwia river in the townships of Ware and Conmee, about one square mile, a large part of which outcrops and magnetic readings indicate is underlaid by iron formation, has been surveyed and mapped during the last two seasons. Outside the mapped area various other outcrops of iron formation in Conmee township, as well as showings of pyrites and molybdenite, were visited and examined.

Iron Formation.—The iron formation consists usually of jasper or chert with which is interbanded numerous narrow seams of mixed magnetite and hematite. In places, however, jasper and hematite are absent and the formation is made up entirely of silica and magnetite. When this is the case the iron is often more evenly distributed throughout the mass and the banding is less prominent. In still other instances the iron constituents are almost or entirely lacking and the formation then consists of a banded, siliceous, slaty or greywacké-like rock. Siderite, more or less impure, is also found locally.

The enclosing rocks are greenstones and green schists, presumably of Keewatin age, which show in places considerable evidence of volcanic origin. There

[1] Op. cit. See pages 113–129.

is also, about half a mile north of Mokomon station, at a small rock cut on the Canadian Northern railway, an outcrop of breccia or conglomerate, the pebbles in which are near y all of banded jasper and iron ore. This outcrop is just southeast of the iron formation proper. The only rock that was noted cutting the iron formation, is in the southwestern part of the map sheet where a white-weathering dike with porphyritic crystals of feldspar is seen to penetrate it.

Folding and crumpling of the iron formation is common while the strike of the undistorted portions varies, in different parts of the field, from nearly east and west to almost north and south.

Throughout the area mapped outcrops are numerous on the hills, though the valleys are heavily drift covered. A few scattered test pits and several boreholes have been sunk. Nowhere, however, has the iron been found sufficiently concentrated to constitute an ore. A number of average samples of mixed iron and jasper from different parts of the field show an iron content varying from 16 to 30 per cent, with correspondingly high silica. A second batch of samples, taken from the siliceous magnetite areas where jasper and hematite are lacking, show an iron content of 20 to 35 per cent, the latter figure being obtained from a sample taken across a width of about six feet of the richest looking part of the exposure.

Speaking in general, this banded iron formation which, in its various phases, occurs scattered over the whole of northern Ontario, and which has from time to time been the object of considerable attention on the part of those interested in iron ores, has, so far, not proved to be of very great economic importance. In its natural state it is, so far as known, too low in iron to be of value. Attempts at artificial concentration have, up to the present, proved commercial failures, while in only one or two instances have natural concentrations of secondary ore in bodies of workable size been found associated with it.

Pyrites.—On lots B and C, concession V, township of Conmee, in the hills just to the south of Brulé creek, and about half a mile west of the Canadian Northern railway track, some work in the shape of strippings and shallow test pits has been done on showings of iron pyrites. The deposits are found in a belt of iron-stained, banded siliceous rock striking east of north, close to which outcrops of banded jasper and magnetite occur.

In several of the openings a width of about six feet of solid pyrites, apparently of good quality, grading at the sides into mixed pyrites and rock, is exposed. At other places the pyrites carries considerable intermixed magnetite, pyrrhotite, and silica while some of the openings show only heavily iron-stained rock. Much of the country is heavily drift covered. The deposits should be worthy of further attention with the object of determining their extent and value.

Molybdenite.—A mile or so west of Hume station on the Canadian Northern railway, on the southwest quarter of the south half of lot B, concession III, in Conmee township, a 50 foot shaft has been sunk on an outcropping of molybdenite ore. The molybdenite is found associated with quartz in a vein striking a little north of east and traversing a dike of syenite porphyry which, in turn, cuts the green schists of the district. It is disseminated through the quartz, and sometimes the adjacent wall rock, in fine flakes and films. A little calcite also occurs with it in the vein, while iron, and possibly copper pyrites is found disseminated in small quantities through both vein and wall rock though more abundant in the latter.

As the shaft was full of water and the neighbouring country is drift covered, it was not possible to determine the extent of the deposit. Some seven or eight hundred feet or more to the east of the shaft, however, the porphyry dike and the quartz vein, here carrying a few scattered flakes of molybdenite, is again exposed in a small outcrop.

THE ORTON MINE.

On lots 56 and 57 west of the Hastings road, Tudor township, Hastings county, Ontario,—otherwise known as the Orton mine—the Tivani Electric Steel Co., of Belleville, mined and shipped during 1912 and 1913 a few tons of titaniferous magnetite to be used experimentally in the production of high grade steel direct from the ore in the electric furnace; a purpose for which, according to Mr. J. W. Evans, one of the designers of the furnace used, the ore is especially adapted.

The development work on the property consists of strippings, three small open cuts and a shaft 32 feet deep. The shaft is not sunk in ore but a ten foot drill hole from the bottom of it is said to have penetrated ore.

The deposits consist of a number of small irregularly shaped bodies of titaniferous magnetite scattered through a massive gabbro-diabase country rock. The ore and rock appear to merge into each other and the former has probably been derived from the gabbro by a process of magnetic segregation. Judging by the magnetometric survey the largest of the individual bodies has, roughly, a length of about 150 feet with a maximum width of 30 or 40 feet, from this they grade down to insignificant patches of a few square feet. The association of rock and ore is so irregular, however, that it is impossible to estimate how much of these areas is occupied by ore and how much by rock. The uncertain and pockety nature of the deposits is well illustrated by the great irregularity of the magnetic attraction and can also be seen where the ore is exposed in the open cuts and strippings.

The analysis of an average sample of the ore is as follows:—

Silica	6·66 per cent.
Iron	49·90 " "
Phosphorus	0·026"
Sulphur	0·256" "
Titanium	7·10 " "

LOTS 16 AND 17, CON. XI, TOWNSHIP OF LAKE.

Titaniferous magnetite deposits similar to those at the Orton mine are also found on the adjoining lots to the west, i.e., on lots 16 and 17, concession XI, of Lake township.

An average sample from one of the pits on lot 17 gave the following:—

Silica	2·10 per cent.
Iron	46·25 " "
Phosphorus	0·016 " "
Sulphur	0·037 " "
Titanium	10·52 " "

LOTS 41, 42, 54 AND 55, HASTINGS ROAD, TUDOR TOWNSHIP.

Deposits of titaniferous magnetite have also been found in the gabbro on lots 41, 42, 54 and 55 east of the Hastings road and on lot 55 west of the road. Where seen in the few small exposures the ore is somewhat lower in iron than that at the Orton mine. Very little work has been done on them.

A sample from lot 42 showed on analysis:—

Silica	14·00 per cent.
Iron	40·75 " "
Phosphorus	0·028 " "
Sulphur	0·287 " "
Titanium	5·10 " "

WALKER PROPERTY; LOT 8, CON. XV, TUDOR TOWNSHIP.

On the east side of a ridge near the south end of lot 8, con. XV, Tudor township, a number of strippings have been made exposing bands of magnetite enclosed in chlorite and hornblende schists. Crystalline limestone can also be seen along side the ore in some of the openings. The strike of ore bands and enclosing schists is approximately north and south. The magnetic attraction is strong in places along the line of strippings and apparently continues through the swamp to the north of the last opening, for a considerable distance. Wherever visible the ore is narrow, the widest single band seen not being over a foot in width, while the aggregate width of all the bands exposed in any one opening would not be over two feet or eighteen inches.

A general sample of ore freed from rock gave on analysis:—

Silica	14·63 per cent.
Iron	55·30 " "
Phosphorus	0·064 " "
Sulphur	0·054 " "
Titanium	0·28 " "

Sufficient time was not available to make a magnetometric survey of the locality during the present season.

THE MALONEY MINE.

About 700 feet south of the Ontario, Belmont and Northern railway, along side the road between concessions I and II, lot 18, Marmora township, a diamond drill hole and a couple of pits have been sunk on a deposit of magnetite. The deposit is entirely drift covered and the only exposure of ore to be seen is in the pit nearest the road. Here an ore body about 25 feet wide, consisting of magnetite with considerable intermixed gangue matter, is exposed. The total area covered by the deposit is, judging by the magnetic survey, about 8,500 square feet. The only rock to be seen in the immediate vicinity of this ore is gabbro but an outcrop of crystalline limestone occurs near the railway track to the north.

An average sample taken by Mr. E. Lindeman in 1911 showed on analysis:—

Iron	47·00 per cent.
Insoluble	21·03 " "
Phosphorus	0·137 " "
Sulphur	0·500 " "
Titanic acid (TiO_2)	0·250 " "

LOT 17, CON. II, MARMORA TOWNSHIP.

About 1,800 feet east of the Maloney pits, on lot 17, concession II, Marmora township, two test pits have been sunk 400 feet south of the Ontario, Belmont

and Northern railway track, on an outcrop of partly decomposed gabbro through which is disseminated some magnetite and hematite. The general appearance of the hematite suggests its deposition from surface waters; the magnetite is probably an original constituent of the rock.

Neither the magnetic survey nor anything to be seen on the property indicates an ore body of any size or importance.

An average sample of the iron-bearing rock gave the following analysis:—

Iron	34·80 per cent.
Insoluble	43·80 " "
Phosphorus	0·134 " "
Sulphur	0·410 " "
Titanic acid (TiO_2)	0·10 " "

NON-METALLIFEROUS DIVISION.

I

LIMESTONES OF THE PROVINCE OF QUEBEC.

Howells Fréchette,

Chief of Division.

The investigation of the limestones in the Province of Quebec, begun in 1914,[1] was continued during 1915. The area examined was principally along the north shore of the St. Lawrence river, and the island of Montreal. A certain amount of time was spent in the southern part of the Province and along the Ottawa river, completing the investigation of those areas visited in 1914. Limestone exposures and quarries were examined, and samples secured, with a view to ascertaining the ecomonic importance and suitability of the various limestones for industrial purposes. Over one hundred and twenty-five samples were collected, and have since been analysed by Mr. H. Leverin of the Mines Branch. The field assistant for the season was Mr. P. E. Poitras.

MONTREAL ISLAND.

ST. GENEVIÈVE.

Immediately to the south of the village of St. Geneviève there are several old quarries, now idle. The limestone is of Chazy age, the beds ranging from one to four feet in thickness. The rock is dark grey in colour, of rather coarse texture and is free from shaly partings.

Sample No.	127	130
Insoluble mineral matter	1·70	2·00
Ferric oxide	·46	·28
Alumina	·16	·06
Calcium carbonate (*a*)	96·43	95·53
Magnesium carbonate (*b*)	1·69	1·46
(*a*) Equivalent to lime	54·00	53·50
(*b*) Equivalent to magnesia	·81	·70

Sample 127, from old quarry one half mile south of St. Geneviève. Last operated by P. Dugas.

Sample 130, from limestone knoll at junction of Ste. Marie road and St. Charles road, about two miles south of St. Geneviève.

[1] Summary Report, Mines Branch, 1914, page 35–53.

LACHINE.

There are few exposures of limestone in the neighbourhood of Lachine and little quarrying is done, although the overburden is generally very light.

Alphonse Latour operates a quarry at the north end of Summerlea Avenue near the Grand Trunk railway, the product being broken stone for concrete and road metal. The rock is a close grained blue limestone belonging to the Trenton group. The beds average about 6 inches in thickness and include considerable shale. No sample was taken.

MONTREAL.

St. Denis Ward.

Within the limits of this ward, which lies immediately northeast[1] of Mile End station of the C.P.R., a great deal of limestone has been quarried for building stone and for lime. While many of the quarries have been abandoned and their sites built over, there are still a number of small and a few large quarries in operation.

The following analysis[2] will serve to indicate the variation in composition of the stone.

Sample No.	135A	135B	136	137	138
Insoluble mineral matter	2·00	2·56	1·80	2·20	5·24
Ferric oxide	·52	1·23	·50	·60	·21
Alumina	·42	2·11	·31	·14	·31
Calcium carbonate (*a*)	94·64	78·28	91·87	91·25	92·85
Magnesium carbonate (*b*)	1·88	16·07	5·32	6·12	1·59
(*a*) Equivalent to lime	53·00	43·84	51·45	51·00	52·00
(*b*) Equivalent to magnesia	·91	7·69	2·55	2·93	·76

Sample 135A—from lower beds (7 feet) in the quarry of the Institution des Sourds-Muets, situated at the intersection of St. Lawrence boulevard and De Castelman street. The stone is light-grey, coarse textured with irregular fracture. The bedding is heavy and free from shale.

Sample 135B—from upper beds (12 feet) of the same quarry. This stone is a hard, dark blue-grey with sub-conchoidal fracture. The beds vary from 6 inches to 3 feet thick.

Sample 136—from Paysan's quarry, the northermost of a series of quarries lying between Boyer, Marquette, and Daniel streets and St. Michel road, known as the Villeray group. This stone is dark grey, of good texture, free from shale and in heavy beds.

Sample 137—from Gagnon's quarry of the same group. The stone is light grey, clean and occurs in heavy beds.

Sample 138—from the lower 14 feet of Joseph Gravel's quarry, situated on Chambord street, to the north of the C. P. R. The stone represented by this sample is thinly bedded, fine grained, of very dark colour and contains interbedded shale. The output of this quarry is crushed stone only.

[1] It is the custom in Montreal to speak of such streets as Craig and St. Catherine as running east and west, although their course is more nearly northeast and southwest. In order, therefore, to avoid confusion in giving directions within the city limits, the local custom is followed in this report.

[2] For other analyses see page 39, Mines Branch Summary Report for 1914.

To the north of Gravel's, the Stinson-Reeb Builders' Supply Co., Ltd., likewise are quarrying stone for crushing.

To the east of these quarries O. Martineau et Fils operate very extensive workings with a large crushing plant, and stone dressing mill. The stone is cut and dressed for building purposes and is similar to that of sample 137.

De Lormier Ward.

Immediately to the north of the C. P. R., and facing De Lormier avenue, is the quarry and plant of the Sovereign Lime Works. Stone from this quarry is used for lime burning; it is a fairly coarse grained, dark grey limestone. The beds vary in thickness from a few inches to nearly 1½ feet. A small amount of shale occurs between some of the beds.

The following analysis is of a sample representative of those beds used for lime burning:—

	Sample No. 134
Insoluble mineral matter	1·90
Ferric oxide	·21
Alumina	·35
Calcium carbonate (*a*)	96·25
Magnesium carbonate (*b*)	1·59
(*a*) Equivalent to lime	53·90
(*b*) Equivalent to magnesia	·76

A short distance east of the above quarry is that of the Delormier Quarry Co., on Iberville street, the rock from which is crushed and used principally for road metal and concrete. It is fine grained, tough, very dark grey, thinly bedded limestone containing interbedded shale. The general character of the rock is similar to that of the lower portion of Joseph Gravel's quarry.

Rosemont Ward.

The quarry of Rogers and Quirk on Iberville street is situated immediately opposite that last described, the stone being the same in both.

About one and a half miles east of Rogers and Quirk's quarry is that of Joseph Rheaume on Rosemont boulevard. The upper portion of this quarry is in "banc rouge," the lower in fine grained, dark grey limestone interbedded with shale. The product is crushed stone and rubble.

The following analysis is of a sample representative of the lower 15 feet of the face:—

	Sample No. 144
Insoluble mineral matter	15·06
Ferric oxide	·74
Alumina	1·36
Calcium carbonate (*a*)	79·47
Magnesium carbonate (*b*)	1·21
(*a*) Equivalent to lime	44·50
(*b*) Equivalent to magnesia	·58

Hochelaga Ward.

The Hochelaga quarry, operated by John G. Poupore Co., Ltd., is situated on Nicolet street, between Forsythe and Hochelaga streets. The stone is a very fine grained, soft, almost black limestone. Considerable shale occurs between the beds, which have a maximum thickness of one foot. Sample 139 is representative of the stone in the lower 12 feet of the quarry—the beds at present being worked.

	Sample No. 139
Insoluble mineral matter	19·54
Ferric oxide	·74
Alumina	·92
Calcium carbonate (*a*)	75·35
Magnesium carbonate (*b*)	2·63
(*a*) Equivalent to lime	42·20
(*b*) Equivalent to magnesia	1·76

Mercier Ward.

R. C. Dickson owns and operates a quarry at the corner of Sherbrooke and Dickson streets. The stone is almost black and is fine grained, with angular to subconchoidal fracture. The beds range up to 10 inches in thickness, with a small amount of shale interbedded. The product of the quarry is broken stone and rubble. The following analysis is of an average sample:—

	Sample No. 143
Insoluble mineral matter	12·22
Ferric oxide	·21
Alumina	·81
Calcium carbonate (*a*)	83·75
Magnesium carbonate (*b*)	2·52
(*a*) Equivalent to lime	46·90
(*b*) Equivalent to magnesia	1·21

COTE ST. MICHEL.

A short distance east of Montee St. Michel on St. Michel Road two quarries are being operated at present. The easterly one is that of Quinlan and Robertson, Ltd. In it three kinds of stone are exhibited. The upper 5½ feet is "banc rouge," the next 10 feet is a close grained, very dark limestone containing shale partings. These are underlain by a light grey coarse limestone, free from visible impurities and occurring in heavy beds. Five feet of this clean grey limestone is exposed. The product is crushed stone exclusively.

Just west of the above quarry is one owned and operated by Aldeas Turcot. These workings are in rock of a slightly lower horizon than in the case of the preceeding pit. The "banc rouge" is not encountered here. The upper seven feet consist of the dark, shaly limestone, while the succeeding 10 feet are the light grey, clean limestone. The dark stone is broken for rubble and road metal and the light, worked for building purposes—the waste from this is sold to the lime burners in Montreal.

	Sample No. 218	219	220
Insoluble mineral matter	4·02	1·64	1·20
Ferric oxide	·43	·17	·31
Alumina	·81	·53	·29
Calcium carbonate (*a*)	90·21	95·70	97·16
Magnesium carbonate (*b*)	2·65	1·53	1·25
(*a*) Equivalent to lime	50·52	53·60	54·41
(*b*) Equivalent to magnesia	1·27	·73	·60

Sample 218, from the quarry of Quinlan and Robertson, Ltd. It represents the very dark shaly limestone.

Sample 219 from Turcot's quarry. This is the light grey stone.

About one mile west of the above mentioned workings is a group of several quarries, only three of which are being operated. The proprietors are Jules Petitjean, Clovis Boucher and O. Limoges. The strata in the various workings are essentially similar, the section exposed being as follows:—

Top 3′—thinly bedded dark grey limestone with some shale partings.
Middle 9′—light grey, fairly coarse, clean limestone; beds up to 4′ thick.
Bottom 6′—dark bluish grey, somewhat impure limestone.

The products of these quarries comprise building stone, rubble, road metal, and stone for lime burning. The last mentioned is obtained entirely from the light grey beds.

Sample 220 (see preceding table) from Petitjean's quarry, represents the light grey stone, that is, the middle nine feet of this quarry section.

ST. LAURENT.

On the south side of the Jacques Cartier Union branch of the Grand Trunk railway; about ½ mile northeast of St. Laurent station, is a large quarry operated by the L. Deguire Quarry Co.

The stone which for the greater part is thinly bedded, is a very dark grey limestone. Its texture varies from fine to rather coarse.

Sample 142 is an average of the face and represents a vertical section of fifty feet.

	Sample No. 142
Insoluble mineral matter	6·92
Ferric oxide	·71
Alumina	·63
Calcium carbonate (*a*)	86·06
Magnesium carbonate (*b*)	4·05
(*a*) Equivalent to lime	48·30
(*b*) Equivalent to magnesia	1·94

On the north side of the track, opposite the above quarry, are the abandoned workings of Stanislas Jarry.

BORDEAUX.

There are a number of small quarries in the neighbourhood of Bordeaux, none of which are being operated at present.

Sample 140 represents the stone of the top $4\frac{1}{2}$ feet in the quarry of the Montreal Prison. This quarry is situated half a mile south of the prison and is almost full of water. The stone is light grey, fairly coarse in texture, and occurs in solid beds about two feet thick.

	Sample No. 140
Insoluble mineral matter	2·00
Ferric oxide	·43
Alumina	·11
Calcium carbonate (*a*)	95·18
Magnesium carbonate (*b*)	1·90
(*a*) Equivalent to lime	53·30
(*b*) Equivalent to magnesia	·91

CARTIERVILLE.

Immediately west of the Park and Island electric railway near the village of Cartierville is a group of quarries from which dressed building stone, curbs, and crushed stone are obtained. At the time of visiting, only two were being worked.

Joseph Lapointe operates a small quarry and produces dressed stone. The rock is light grey and fairly coarse in texture and is free from shale. It occurs in beds from 8 inches to 16 inches in thickness. Further to the west R. T. Smith and Co. are producing crushed stone. The material is the same as that in quarry.

	Sample No. 141
Insoluble mineral matter	7·12
Ferric oxide	·69
Alumina	·65
Calcium carbonate (*a*)	88·75
Magnesium carbonate (*b*)	2·28
(*a*) Equivalent to lime	49·70
(*b*) Equivalent to magnesia	1·09

Sample 141, average from Smith and Co.'s quarry.

ISLE BIZARD.

At present there are no quarries in operation on Isle Bizard, although limestone of good grade was obtained from this locality some 25 years ago.

Near the road which crosses the island from the village of Isle Bizard, an old quarry is to be seen just north of the height of land. The stone is very similar to that at St. Geneviève, near by, though in this quarry the beds are less solid. Sample 128 is an average from this opening.

On the property of Hermenegilde Clement is another old quarry. The stone is light grey, of good quality and occurs in beds up to two feet in thickness. No. 129 is an average sample of the beds exposed.

Sample No.	128	129
Insoluble mineral matter	2·30	3·20
Ferric oxide	·70	·74
Alumina	·04	·36
Calcium carbonate (*a*)	95·00	93·12
Magnesium carbonate (*b*)	1·92	2·63
(*a*) Equivalent to lime	53·20	52·15
(*b*) Equivalent to magnesia	·92	1·26

ISLE JESUS.

VILLAGE ST. MARTIN.

About one mile northeast of St. Martin village is a group of quarries on the properties of Damien Bigras, Alma Gauthier and Elie Bigras. Many of these are small, being but 6 or 8 feet in depth. The stone is bluish grey, medium to coarse in texture and rather hard. The beds are from $1\frac{1}{2}$ to 3 feet thick, with regular and well spaced jointing. The principal product has been curb stone for the city of Montreal. Plouffe, Lagacé et Cie operate a quarry for crushed stone on the property of Alma Gauthier. The pit is 16 feet deep, the stone of the upper 10 feet being similar to that described above and that of the lower six feet thinly bedded with shale partings. Sample 148 is representative of the upper 10 feet of this quarry.

About two miles north of the foregoing is a quarry owned by Godfrey Lecavalier, on the St. Elzear road, one mile from the C. P. R. tracks. The stone is very coarse grained, from brownish to light grey. The beds are about one foot thick and show rather frequent jointing. The pit is 11 feet deep. It was not being worked at the time of visiting and was flooded to a depth of about five feet. Sample 147 is representative of the upper six feet.

Sample No.	147	148
Insoluble mineral matter	4·00	4·94
Ferric oxide	1·14	1·36
Alumina	·64	1·34
Calcium carbonate (*a*)	91·07	81·69
Magnesium carbonate (*b*)	2·19	11·11
(*a*) Equivalent to lime	51·60	45·75
(*b*) Equivalent to magnesia	1·05	5·32

CAP ST. MARTIN.

To the southwest of the main highway on the southern side of the Quebec branch of the C. P. R., half a mile east of St. Martin Junction, is the quarry of L. Paquette and immediately to the south thereof is that of Arthur Paquette. Both quarries are in a good grade of light grey, medium grained limestone. The principal products are curb and dressed building stone.

Between L. Paquette's quarry and the highway is an old quarry, now idle.

A short distance east of the highway the St. Laurent Quarry Co., Ltd., have their workings. The face of the quarry is 250 feet long and 23 feet high. The stone is light grey to greenish grey and is medium to very coarse in texture.

The beds range up to three feet in thickness. The entire output is crus ed for concrete and road purposes.

Sample 145 is an average of the 23 feet of strata exposed.

	Sample No. 145
Insoluble mineral matter	3·28
Ferric oxide	·57
Alumina	·57
Calcium carbonate (*a*)	92·77
Magnesium carbonate (*b*)	2·02
(*a*) Equivalent to lime	51·95
(*b*) Equivalent to magnesia	·97

On the high land immediately to the south of the foregoing there are some eight or nine small quarries producing curb and dressed building stone.

VILLAGE BELANGER.

A number of small quarries are situated just west of this village. The stone, which is wrought into curbs, is a medium grained, light to rather dark grey limestone, occurring in heavy beds free from shale. Sample 146 was taken in the quarry of Alfred Chartrand on the property of Wilfred Allaire.

	Sample No. 146
Insoluble mineral matter	2·54
Ferric oxide	1·07
Alumina	·63
Calcium carbonate (*a*)	89·73
Magnesium carbonate (*b*)	6·52
(*a*) Equivalent to lime	50·25
(*b*) Equivalent to magnesia	3·12

ST. VINCENT DE PAUL.

Midway between St. Martin Junction and St. Vincent de Paul station of the C. P .R. are several quarries, only one of which, however, is being worked. This is operated by Napoleon Brunet[1]. The stone is dark grey, of medium texture and occurs in beds up to four feet thick. The jointing permits of large size blocks being secured.

Adjoining this quarry are the abandoned workings of the Standard Quarries, Ltd.

The quarry of Ulric Sauriol is situated on the bluff overlooking the river, about 1½ miles south of the foregoing. The upper beds consist of thin, shaly, dark limestone while the lower beds are similar to those in Brunet's quarry. This is about worked out.

The quarry of the St. Vincent de Paul Penitentiary lies about 1½ miles northwest of the penitentiary buildings to which it is connected by a tram line. The stone is light grey and fairly coarse with good cutting properties. The beds range up to four feet in thickness. Although the jointing is somewhat irregular,

[1] See Mines Branch Summary Report, 1914, page 40, for analysis of rock.

fair sized blocks can be obtained. The stone is used exclusively in and about the penitentiary.

Sample 152 is representative of the stone in the above quarry.

	Sample No. 152
Insoluble mineral matter	2·52
Ferric oxide	·93
Alumina	·27
Calcium carbonate (*a*)	93·82
Magnesium carbonate (*b*)	2·54
(*a*) Equivalent to lime	52·50
(*b*) Equivalent to magnesia	1·22

Roger Frenette owns and operates a quarry on the St. Elzear road about one mile west of the penitentiary workings. The stone in both localities is practically the same. The principal product is curbing for the city of Montreal.

ST. FRANCOIS DE SALES.

There are a number of important limestone quarries situated along the Terrebonne road between three and four miles from St. Vincent de Paul. The most southern one is that of O. Lapierre. This quarry produces dressed stone, close grained and of a dark grey colour. The beds range from one to 2½ feet in thickness and are free from shale.

A short distance northeast of this, to the north of the road, is the quarry of Charbonneau Frères—now idle. The stone is similar to that in the last mentioned opening.

J. O. Labelle et Cie. have recently opened a quarry about half a mile farther to the northeast. The stone is similar to that in the two previous quarries. The beds are massive and range up to 4½ feet in thickness.

In the quarry of Felix Labelle Quarry Co. Inc. massive beds are encountered which exhibit widely spaced rectangular jointing. Blocks 20 feet square by 4½ feet thick can be obtained . The product of this quarry is dressed building stone, rubble and road metal. This, the largest quarry in the district, is situated on the southeast side of the road and is served by a siding from the C. P. R. Quebec branch.

On the opposite side of the road is a group of four quarries also served by a railroad siding. The stone is the same as in the quarries described above.

The operators are: Montreal Concrete Co. Ltd., Louis Labelle et Cie., Laval Quarry Co., and Kennedy Construction Co. Ltd.

Sample No.	149	150
Insoluble mineral matter	1·68	2·20
Ferric oxide	·96	·63
Alumina	·30	·49
Calcium carbonate (*a*)	90·60	92·85
Magnesium carbonate (*b*)	6·81	4·28
(*a*) Equivalent to lime	50·70	52·00
(*b*) Equivalent to magnesia	3·28	2·05

Sample 149 from the quarry of O. Lapierre.
Sample 150 from the quarry of Felix Labelle Quarry Co. Inc. Average of 35 feet of strata.

TERREBONNE COUNTY.[1]

About two miles due southwest of Shawbridge a band of impure crystalline limestone outcrops by the roadside near Lake Marois. It is of no commercial importance so no sample was taken.

A light grey, thinly bedded shaly limestone is exposed in an old quarry on the farm of Napoleon Lesage, three miles east of Ste. Thérèse. The weathering of the stone had progressed to such a degree that it was impossible to secure a satisfactory sample with the means at hand.

Another small, old quarry was visited on the farm of Antoine Drouin, on the St. Margaret road, about four miles east of St. Jerome. The rock is similar in appearance to that at Valleyfield.[2] The stone is light buff to grey and occurs in thin beds, which outcrop for a mile or more along the St. Margaret road.

	Sample No. 154
Insoluble mineral matter	15·44
Ferric oxide	1·46
Alumina	2·38
Calcium carbonate (*a*)	46·43
Magnesium carbonate (*b*)	34·44
(*a*) Equivalent to lime	26·00
(*b*) Equivalent to magnesia	16·48

Sample 154 was taken in the old quarry on Drouin's farm.

L'ASSOMPTION COUNTY.

There is a small quarry on the farm of Ubald Hogue, one mile west of St. Lin. The rock which shows considerable folding and distortion is in part marmorized. The unaltered portion is very fine grained, and dark grey to almost black. The lowest bed of the quarry is two feet thick and shows very little disturbance.

Sample 155 is an average of the rock exposed in this quarry.

	Sample No. 155
Insoluble mineral matter	11·20
Ferric oxide	·78
Alumina	·72
Calcium carbonate (*a*)	74·34
Magnesium carbonate (*b*)	13·46
(*a*) Equivalent to lime	41·65
(*b*) Equivalent to magnesia	6·44

[1] See Mines Branch Summary Report, 1914, page 39.
[2] See Mines Branch Summary Report, 1914, p. 40.

MONTCALM COUNTY.

At one time lime was burned in a small kiln on lot 28, range IX, Rawdon township, the stone being obtained from a narrow band of crystalline limestone nearby. While this limestone is of apparently good quality, it contained such a quantity of large inclusions of foreign rock within the band that the whole is of no commercial value.

A thinly bedded limestone, underlain by Potsdam sandstone, was seen in the bed of the Ouareau river at St. Ligouri. Sample 166 is an average of this limestone.

About 35 feet of limestone beds are exposed in the banks of the Ouareau river near the crossing point of the St. Jacques-Joliette road. The upper 20 feet consist of coarse grained, grey to brownish limestone, and the lower 15 feet of dark blue, close grained limestone. While the average thickness of the beds is about eight inches, some layers are as much as 1½ feet.

Sample 167A is representative of the lower 15 feet.
Sample 167B is representative of the upper 20 feet.

Sample No.	166	167A	167B
Insoluble mineral matter	32·00	4·86	2·74
Ferric oxide	—	·28	·19
Alumina	—	·52	·21
Calcium carbonate (*a*)	—	92·39	94·35
Magnesium carbonate (*b*)	—	1·52	2·96
(*a*) Equivalent to lime	24·05	51·74	52·84
(*b*) Equivalent to magnesia	10·88	·73	1·42

JOLIETTE COUNTY.

Joliette has long been an important lime and limestone producing centre. At present there is but a small production of limestone from a couple of quarries and only one small kiln is in operation within the town itself; while about two miles southwest of the town are situated the large, modern lime plant and quarry of the Standard Lime Co., Ltd.

This quarry has a working face 32 feet high. The stone is very dark grey, rather close grained and occurs in layers averaging about one foot in thickness. The product is crushed stone and stone for lime burning. The lime plant produces hydrated, as well as quick lime.

Sample No.	160	161
Insoluble mineral matter	2·50	1·00
Ferric oxide	·25	·15
Alumina	·21	·45
Calcium carbonate (*a*)	93·37	97·94
Magnesium carbonate (*b*)	2·36	·87
(*a*) Equivalent to lime	52·29	54·85
(*b*) Equivalent to magnesia	1·13	·42

Sample 160 is representative of the lower 7 feet of the quarry.
Sample 161 is representative of the 17 feet above the foregoing.

Near the quarry of the Standard Lime Co. there is that of Theo. Dussault et Cie., now idle and almost full of water. The products were masonry stone, rubble, and stone for lime burning.

On the east side of L'Assomption river to the south of the bridge at Joliette is located the joint quarry of Arnaud et Beaudry, Geo. Desroches and Joseph Beaudry. These three operators are working three separate horizons within the same quarry. The thin upper beds, about 19 feet in total thickness, are being taken out by Joseph Beaudry for crushed stone and rubble. This stone is very dark grey to black, tough and fine grained. It contains much shale along the bedding and also cherty nodules and bands, as well as some quartz and pyrite.

George Desroches (dit Tite Desroches) quarries the next lower seven feet, from which he produces both rough and dressed masonry stone. These beds which are thicker than those above, are sound and possess good cutting properties. In colour the stone varies from a light grey to a somewhat dark brownish grey.

The lowest beds are likewise heavy but are unfit for dressed stone owing to frequent and irregular jointing. These are used by Arnaud et Beaudry for lime burning.

	Sample No. 156	157	158A
Insoluble mineral matter	·80	2·00	2·00
Ferric oxide	·30	·50	·19
Alumina	·20	·60	·15
Calcium carbonate (*a*)	97·59	95·98	96·60
Magnesium carbonate (*b*)	1·17	1·21	1·04
(*a*) Equivalent to lime	54·65	53·75	54·10
(*b*) Equivalent to magnesia	·56	·58	·50

Sample 156—average sample of stone quarried by Joseph Beaudry.

Sample 157—average sample of stone quarried by Geo. Desroches.

Sample 158A—average sample of the stone quarried by Arnaud et Beaudry and used for lime burning.

About two miles due northeast of Joliette are the lime kilns and quarry of Néré Goulet. The plant was idle when visited. About six feet of strata are exposed in a long narrow quarry, consisting of thin beds of brownish grey, fine to medium grained limestone carrying very little shale. The following is an average sample:—

	Sample No. 162
Insoluble mineral matter	1·62
Ferric oxide	·19
Alumina	·09
Calcium carbonate (*a*)	96·34
Magnesium carbonate (*b*)	1·25
(*a*) Equivalent to lime	53·95
(*b*) Equivalent to magnesia	·60

In the bed of L'Assomption river, about four miles northwest of Joliette, some thin beds of siliceous Beekmantown(?) limestone are exposed at low water.

This stone is used locally for foundations, but is not of commercial importance. No sample was taken.

On lot 6, range IV, Kildare township, a small exposure of crystalline limestone is to be seen near the mouth of an old gold prospect tunnel. Sample 164 was taken at this point.

In the neighbourhood of Grand Chaloupe about three miles south of St. Elizabeth, there are a number of small quarries which are worked intermittently for foundation stone, road metal, and stone for lime burning. Sample 169 is representative of the 12 feet of strata exposed in a quarry on the property of Madame (Vve.) Lazard Guilbault.

Sample No.	164	169
Insoluble mineral matter	24·14	1·74
Ferric oxide	—	·12
Alumina	—	·38
Calcium carbonate (*a*)	—	97·59
Magnesium carbonate (*b*)	—	·67
(*a*) Equivalent to lime	38·35	54·65
(*b*) Equivalent to magnesia	2·13	·32

On the farm of Ovide Farland, 3 miles from St. Elizabeth, on the road to Berthier, there is a quarry from which stone has been taken for road metal. In this quarry three varieties of stone occur. The upper beds are dark brownish grey, very fine grained, hard dolomite. The lowest beds are light brown, fairly fine grained, friable dolomite. Interposed between these is a macrocrystalline black calcite, two feet in thickness.

Sample No.	170A	170C
Insoluble mineral matter	7·36	3·56
Ferric oxide	1·43	1·02
Alumina	·65	·60
Calcium carbonate (*a*)	51·78	60·53
Magnesium carbonate (*b*)	36·91	33·33
(*a*) Equivalent to lime	29·10	33·90
(*b*) Equivalent to magnesia	17·66	15·95

Sample 170A represents the dark upper beds.
Sample 170C represents the light lower beds.

BERTHIER COUNTY.

Along the Bayonne river, near the boundary between Berthier and Joliette counties, black, fine grained, thin bedded limestone is exposed at frequent intervals for a distance of two or three miles. This stone contains considerable interbedded shale.

On the west shore of the Chicot river a short distance above St. Cuthbert, there is a quarry on the farm of Joseph Clement. The following section is exposed: Top six feet, overburden; six feet, hard, light grey limestone; four feet, dark blue limestone; twelve feet, light grey banded limestone. All the stone is thick bedded,

close grained and hard. The product of the quarry is road metal and building stone. Sample 174 is an average sample of the lower 12 feet.

	Sample No. 174
Insoluble mineral matter	6·78
Ferric oxide	·14
Alumina	1·46
Calcium carbonate (*a*)	81·41
Magnesium carbonate (*b*)	9·51
(*a*) Equivalent to lime	45·59
(*b*) Equivalent to magnesia	4·55

A short distance farther down stream there are three small quarries from which Gaspard Desfouds secures stone for lime burning as well as for road metal. The stone is similar to that represented by sample 174.

On the farm of Joseph Lacourse $2\frac{1}{4}$ miles due west of St. Barthélémi is an old quarry, long abandoned. The stone is close grained and almost black, the beds being about one foot thick with shale bewteen.

Immediately south of the village of St. Barthélémi, Stack and Leger, contractors, have been quarrying limestone for road metal on the property of Wilfred Drainville. The stone, which is apparently of the Trenton formation, is very dark blue and close grained. It contains much interbedded shale and has a decided odor of petroleum. About 13 feet of strata are exposed. No. 172 is an average sample of the stone from this quarry.

	Sample No. 172
Insoluble mineral matter	11·50
Ferric oxide	·71
Alumina	·49
Calcium carbonate (*a*)	85·21
Magnesium carbonate (*b*)	2·36
(*a*) Equivalent to lime	47·72
(*b*) Equivalent to magnesia	1·13

MASKINONGE COUNTY.

About one mile southwest of St. Justin there are two quarries, long since abandoned. The stone is similar to that of Stack and Leger's quarry.

Very fine grained black limestone is exposed in the bed of Petite Rivière du Loup, about $1\frac{1}{2}$ miles down stream from St. Ursule. The stone is very brittle but sound and free from shale. The beds range from six inches to two feet in thickness.

Quarrying could be carried on, to a limited extent, in the bed of the river, during periods of low water, but owing to heavy overburden along the shores no extensive quarrying could be undertaken. Sample 171 is representative of this stone.

	Sample No. 171
Insoluble mineral matter	8·88
Ferric oxide	·60
Alumina	·44
Calcium carbonate (*a*)	87·82
Magnesium carbonate (*b*)	2·54
(*a*) Equivalent to lime	49·18
(*b*) Equivalent to magnesia	1·22

ST. MAURICE COUNTY.

Dark grey to brownish grey, rather coarse grained limestone is exposed in the bed of the Machiche river at the bridge directly northeast of St. Barnabé. There is practically no interbedded shale. Most of the beds are thin, though some run as high as 15 inches. There is no opportunity for quarrying except to a limited extent along the shores of the river, as the country carries a heavy overburden of clay and sand. Sample 176B is representative of the beds exposed.

Three narrow bands of crystalline limestone are to be seen within half a mile of St. Boniface station. The stone is coarse grained and carries a small percentage of graphite, as well as included masses of foreign rock and stringers of quartz.

Sample 177 represents the cleanest parts of the most southeasterly band which lies due east of the station. Judging from the exposures, these bands are absolutely of no economic value as a source of limestone.

Sample No.	176B	177
Insoluble mineral matter	1·50	20·25
Ferric oxide	·48	—
Alumina	·10	—
Calcium carbonate (*a*)	95·43	—
Magnesium carbonate (*b*)	·92	—
(*a*) Equivalent to lime	53·44	43·26
(*b*) Equivalent to magnesia	·44	·44

CHAMPLAIN COUNTY.

The quarry of La Compagnie de Marbre du Canada, Ltée., is situated about three miles northwest of St. Thècle. The marble is a crystalline limestone of Laurentian age and has a rather coarse grain. It is in part salmon pink and part white. Within the quarry are seen infolded masses and bands of mica schist. The marble itself carries some flake mica and quartz veinlets. Sample 175A is representative of the clean marble.

The old quarry of the Canada Iron Corporation, at Radnor, was visited. The stone from this quarry was used for flux in the company's blast furnace nearby. It is a dark brownish grey, close grained limestone. A small amount of shale occurs between the beds which vary in thickness from five to fourteen inches.

Sample 178 is an average of the 10 feet of strata exposed.

On the property of Maurice Lacoursière, about four miles from St. Anne de la Pérade, a quarry has been operated recently along the face of the east bank of

the St. Anne river. At this point the bank rises to a height of 25 feet above low water level. The upper five feet consists of clay and soil. The following 20 feet is a close, fine grained dark bluish grey limestone, with interbedded shale. The beds average less than six inches in thickness. The stone was used for road metal. Number 179 is an average sample from this quarry.

Sample No.	175A	178	179
Insoluble mineral matter	5·40	8·40	11·30
Ferric oxide	·19	·15	·58
Alumina	·13	·15	·44
Calcium carbonate (*a*)	91·29	90·35	84·00
Magnesium carbonate (*b*)	3·11	1·21	2·77
(*a*) Equivalent to lime	51·12	50·06	47·04
(*b*) Equivalent to magnesia	1·49	·58	1·33

PORTNEUF COUNTY.

Along the St. Anne river, from the last mentioned quarry to St. Albans' limestone is exposed in the bed of the river at very frequent intervals, and in places a considerable thickness of strata show on the steep banks.

Quarrying would be practicable at very few places, owing to the heavy overburden of clay and sand. Near the St. Albans bridge, about 60 feet of strata are cut by the river, a narrow canyon being formed.

About 2½ miles southeast of the St. Albans bridge is one of the most important groups of quarries in the Province. The workings are located at the town of St. Marc, on both sides of the Grand Trunk Pacific railway. The stone in the various quarries is similar in appearance and general character. It is light brownish grey, of medium grain and possesses excellent working properties. It is free from shale and occurs in thick sound beds with well spaced jointing. The beds vary from two to four feet in thickness. The principal output is dressed building stone, shoddy and rubble. The following is a list of the operators, named in order of quarries from north to south:—

Damase Naud; La Cie. des Carrières de St. Marc; Deschambault Stone Co., (not in operation at time of visiting); Chateauvert Quarry Co., Ltd.,; Naud et Marquis; Quinlan Cut Stone, Ltd., (quarry closed); and Elzear Laforce. Naud et Marquis operate three modern lime kilns and Francis Naud two small pot kilns.

Sample No.	180	181	182	183
Insoluble mineral matter	·40	1·50	·44	·50
Ferric oxide	·12	·51	·15	·12
Alumina	·04	1·11	·61	·14
Calcium carbonate (*a*)	99·14	95·75	97·50	97·50
Magnesium carbonate (*b*)	·63	·63	·54	·69
(*a*) Equivalent to lime	55·52	53·60	54·60	54·60
(*b*) Equivalent to magnesia	·30	·30	·26	·33

Sample 180—Average sample from quarry of La Cie des Carrieres de St. Marc.
Sample 181—Average sample from quarry of Naud et Marquis.

Sample 182—Average sample from quarry of Damase Naud. This is the northermost quarry of the group.
Sample 183—Average sample from quarry of E. Laforce.

Between St. Marc and Portneuf limestone outcrops are numerous along what is known locally as the old Quarry road. Five hundred feet south of the C. P. R. tracks and half a mile east of where the railway crosses the Quarry Road, is an abandoned quarry 15 feet deep and of considerable area. The stone is variable in quality, some of the beds being of brownish grey colour and medium texture while the others are almost black and fine grained. Shaly partings occur between the beds which have a maximum thickness of one foot. Sample 184 is an average sample from this quarry.

A short distance to the south is another old quarry, only three feet deep, in beds belonging to a somewhat higher horizon. The rock is sounder and in thicker beds.

A quarry has been opened by Jackson Bros. on the face of the cliff overlooking the St. Lawrence river at a point about two miles below Grondines. Here 60 feet of strata, probably of the Trenton formation, are being quarried for road metal. The stone is very fine grained, tough and of a dark bluish grey colour. Some beds are as much as three feet thick but the majority are very thin. Sample 190 is representative of the rock in this quarry.

Along the Jacques Cartier river near Pont Rouge, limestone is exposed at numerous points. Ludger Leclerc has done a small amount of quarrying on the west shore, about a quarter of a mile below the paper mill. The stone is brownish to greenish grey, of medium grain, and occurs in beds up to two feet in thickness. Number 186 is an average sample of the 20 feet of strata exposed at this point.

About one mile farther upstream, Louis Doré and Arthur Boivin obtain stone for lime burning on the east bank of the river. Sample 187 is representative of the stone used by them.

On a low ridge about two miles east of Neuville, numerous outcrops of limestone are met with over an area of several hundred acres. The rock is fairly coarse in texture and varies from a light buff to almost black, the darker material showing evidence of poor weathering properties while the buff is sound and apparently of a grade suitable for dressed stone. The beds vary in thickness from a few inches to four feet. Sample 189 is representative of about 20 feet of strata.

Within the above area, on the farms of Wilfred Gauvin, Olivier Darvian and Albert Roshette are several old quarries from which a large quantity of stone has been removed.

Sample No.	184	186	187	189	190
Insoluble mineral matter	1·68	1·60	1·66	2·20	6·32
Ferric oxide	·22	·19	·19	·51	·43
Alumina	·10	·05	·15	·75	·37
Calcium carbonate (*a*)	93·21	95·78	95·10	92·68	87·68
Magnesium carbonate (*b*)	1·48	1·52	1·37	3·50	3·05
(*a*) Equivalent to lime	52·20	53·64	53·26	51·90	49·10
(*b*) Equivalent to magnesia	·71	·73	·66	1·67	1·46

Sample 184 from old quarry between Portneuf and St. Marc.
Sample 186 from quarry of Ludger Leclerc, Pont Rouge.
Sample 187 from quarry of Louis Doré, Pont Rouge.

Sample 189 from old quarry east of Neuville.
Sample 190 from quarry of Jackson Bros., Grondines.

Calcareous shale is exposed in a cut on the G. T. P. railway three quarters of a mile west of Portneuf station. Number 185 is a representative sample.

The bluffs along the St. Lawrence at Cap Sante are formed of calcareous shale. Sample 188 is of this material taken along the cuts of the new highway, 1½ miles west of the village of Cap Sante.

On the opposite shore of the river, the bluffs at Point Platon are of similar material. Owing to the depth to which the rock was weathered, no satisfactory sample could be obtained.

Sample No.	185	188
Insoluble mineral matter	26·08	28·00
Lime	39·20	33·98
Magnesia	1·50	2·03

QUEBEC COUNTY.

Trenton limestone outcrops at various points between Lorette and Montmorency Falls, over a strip of country, narrow in its western limit, but, to the east, widening to about three miles.

Half a mile east of Lorette, Nathan Savard operates a small quarry, producing crushed stone for road metal. The limestone is dark grey and fine grained, the beds being from 6 to 18 inches in thickness and interbedded with shale. Evidence of faulting is seen in the pit which is located in the trough of a sharp syncline. Number 208 is an average sample from this opening.

In a general easterly to northeasterly direction from Lorette to a point a mile or so east of Bourg Royal numerous small quarries are producing road metal. In some instances rough building stone is also obtained, and in others stone for lime burning.

Two types of stone were observed in these quarries, that of the upper beds being dark grey, tough, and of medium grain, and of the lower, dark blue, brittle, and of close texture. The beds, as a rule, are thin, seldom exceeding 12 inches. In certain of the quarries both types of stone are met with, while in others only one or the other is exposed. Shale is universally present as thin partings between the limestone beds. The following analyses are representative of the rocks of this series of quarries:—

Sample No.	194	195	196	197	208
Insoluble mineral matter	2·28	11·30	10·40	4·04	5·14
Ferric oxide	·14	·67	·39	·26	·40
Alumina	·40	·13	·21	·16	·30
Calcium carbonate (*a*)	91·53	86·00	85·14	91·53	91·21
Magnesium carbonate (*b*)	2·74	2·04	2·08	4·55	1·52
(*a*) Equivalent to lime	51·26	48·16	47·68	51·26	51·08
(*b*) Equivalent to magnesia	1·32	·99	1·00	2·18	·73

Sample 194, grey limestone, from Godias Villeneuve's quarry, Charlesbourg.
Sample 195, bluish limestone, from F. X. Pageau's quarry, Charlesbourg.

Sample 196, bluish limestone, from J. B. Page's quarry, Charlesbourg West.
Sample 197, bluish limestone, from Felix Grenier's quarry, one mile east of Bourg Royal.
Sample 208, grey limestone, from Nathan Savard's quarry, Lorette.

The Quebec Brick Company, Limited, operates a large, well equipped quarry, half a mile northeast of the Beauport station of the electric railway. The stone, which is crushed for concrete and road metal, is a hard, close grained, dark blue-grey limestone, occurring in rather thin layers, with considerable interbedded shale.

Adjoining, and west of this quarry is that of Elzear Verreault. The stone is similar to that above described. The product is crushed stone, rubble and dressed building stone. Sample 192 is an average of the limestone (omitting the shale partings) exposed in the 85 foot face.

Other large quarries near Beauport, opened in similar strata, are those owned by Joseph and Honore Giroux, Victor Marcoux, and the estate of Herman Renelle. Giroux's quarry is the only one being worked at present. From it a small quantity of broken stone and rubble is being taken.

Between 15 and 20 small quarries are scattered along the road between Beauport and Kent House. They are worked only at odd times, as the owners have time available from other occupations, or require stone for lime burning. There are numerous small, old-fashioned kilns on many of the farms, which are used only at rare intervals.

The stone is a close grained, hard, dark blue limestone, in beds from 2 to 8 inches thick, and separated by shale. Sample 193 is an average from the quarry of Pierre Robert, in Beauport East.

A sample of 20 feet of strata was taken at the west end of the dam at Montmorency Falls. The limestone is very fine grained, almost black, and thinly bedded, with a small amount of shale on the bedding planes. The composition of this limestone is given below, under sample number 191.

Sample No.	191	192	193
Insoluble mineral matter	6·10	12·04	9·40
Ferric oxide	·36	·54	·64
Alumina	·28	·70	·08
Calcium carbonate (*a*)	90·32	81·75	85·32
Magnesium carbonate (*b*)	1·07	2·42	2·04
(*a*) Equivalent to lime	50·58	45·78	47·78
(*b*) Equivalent to magnesia	·51	1·16	·98

Sample 191, from Montmorency Falls.
Sample 192, from quarry of Elzear Verreault, Beauport.
Sample 193, from quarry of Pierre Robert, Beauport East.

MONTMORENCY COUNTY.

At Chateau Richer a cliff of limestone runs for a couple of miles along the river road, and is capped in some places by small patches of shale. To the north of the cliff the land rises in a series of benches, due to the folding and faulting. Quarries have been opened at various points along the cliff and on the upper levels, the stone throughout being of much the same appearance. It is dark brownish grey, fine grained, hard and tough. The beds seldom exceed one foot in thickness. Shale occurs in small quantity between the beds.

Roberge et Giroux operate a quarry at the west end of the town, from which crushed stone only is produced. Electric power is used to operate the crushing and screening plant. Sample 199 is representative of the rock in this quarry.

J. E. and A. A. Baker operate the quarries of the Chateau Richer Quarry Company, at the east end of the town, producing crushed stone, rubble, and squared masonry stone. In these quarries beds up to 15 inches in thickness are to be found. Sample 200 is an average taken up the face, which is 80 feet high in one place. The plant consists of drills, crushers, screens, bins, etc., operated by steam from four boilers.

An extensive quarry is being worked, but only on a small scale, by the Syndicate of Chateau Richer Quarries. The products are broken stone, rubble and squared masonry stone. No machinery is employed. Sample 201 is an average from this quarry.

Sample No.	199	200	201	207
Insoluble mineral matter	18·64	11·44	4·60	8·62
Ferric oxide	1·24	·43	·47	·36
Alumina	·38	·15	·37	·30
Calcium carbonate (*a*)	74·50	82·96	91·69	86·60
Magnesium carbonate (*b*)	3·21	2·59	1·19	2·42
(*a*) Equivalent to lime	41·72	46·46	51·35	48·50
(*b*) Equivalent to magnesia	1·54	1·24	·57	1·16

Other quarries, none of which are being worked on a large scale, are situated in the neighbourhood of the village of Chateau Richer.

Near Bérubé there is a small quarry on the property of Gaudias Bilodeau, from which stone is taken occasionally for lime burning. The rock is dark bluish grey, close grained, and occurs in thin beds with much shale between. Sample 207 (see above) is an average from about 35 feet of strata.

LAKE ST. JOHN COUNTY.

Stratified limestone is exposed at a number of points along a rather narrow belt bordering the southwest shore of Lake St. John.

One and a half miles east of Chambord Junction, the Standard Cement Company has erected mill buildings with a view to manufacturing cement from the limestone exposed in an old quarry near by. The stone is light grey, with a brownish cast, very fine grained semi-marble occurring in beds up to three feet thick. Streaks of argillaceous matter were seen in many of the beds. Sample 202 is an average of the exposed beds.

Similar stone is being quarried by Price Bros., near the station, for use in their pulp mills. Sample 203 was taken in their quarry.

Midway between Chambord and Chambord Junction the Corporation recently operated a quarry for road metal. The stone is somewhat similar to that in the two last mentioned quarries, but is coarser and less marmorized. A small amount of interbedded shale occurs here. Number 204 is an average sample, representative of the stone in this pit.

	Sample No. 202	203	204
Insoluble mineral matter	12·52	5·90	9·70
Ferric oxide	·39	·86	·87
Alumina	·15	·38	·17
Calcium carbonate (*a*)	83·23	89·21	85·57
Magnesium carbonate (*b*)	3·05	1·25	2·19
(*a*) Equivalent to lime	46·61	49·96	47·92
(*b*) Equivalent to magnesia	1·46	·60	1·05

Hercule Lavoie operates a small quarry on his farm, lot 4, range A, Roberval township. The stone, which is used for road metal, lime burning, and building purposes, is brownish grey, close grained and tough. The beds are heavy, measuring as much as three feet, but, owing to argillaceous streaks along the bedding, these beds would split readily into much thinner slabs. Sample 205 is an average of the quarry, and represents about 15 feet of strata.

Similar stone is found in the quarry of Simon Simon, within the town of Roberval. In this pit one bed is five feet in thickness, but splits into layers two and three feet thick in the process of quarrying.

A mile and a half southeast of the town, on the farm of Louis Boily, a quarry is operated for road metal by the township of Roberval. The stone exposed is similar to that in Lavoie's quarry.

On lot 11, range I, Ouiatchouan township, Joseph Belanger quarries limestone for lime burning and road metal. The stone is fine grained, tough, and is dark grey, some beds being of a brownish, and other of a bluish shade. The beds range up to two feet in thickness, and carry very little shale. The quarry is situated near the contact of a granite intrusion. Sample 206 is representative of the stone quarried.

	Sample No. 205	206
Insoluble mineral matter	10·00	7·46
Ferric oxide	·89	·83
Alumina	·15	·17
Calcium carbonate (*a*)	85·30	86·30
Magnesium carbonate (*b*)	·92	2·44
(*a*) Equivalent to lime	47·77	48·33
(*b*) Equivalent to magnesia	·42	1·17

LEVIS COUNTY.

The cliffs at Levis are formed of shales dipping steeply to the south, with numerous intercalated thin beds of limestone and calcareous shale. Several beds of limestone conglomerate are also present, some of which are calcareous throughout, while others contain much quartz sand. Some of the conglomerate beds are very thick, as may be seen in the cliff at the east end of the town. Large bodies of conglomerate are exposed to the north and west of Mount Marie Cemetery.

Several small quarries are located in these conglomerate outcrops, adjacent to the cemetery.

An outcrop of massive, fine grained, light grey limestone is being quarried for crushed stone by the Levis Tramway Company. It is situated to the north of the cemetery on property owned by the Fabrique St. Joseph de Levis. The

stone, which is free from visible impurities, is partly marmorized, and shows distortion. Sample 198 is an average.

	Sample No. 198
Insoluble mineral matter	4·72
Ferric oxide	·31
Alumina	·15
Calcium carbonate (*a*)	89·89
Magnesium carbonate (*b*)	4·55
(*a*) Equivalent to lime	41·72
(*b*) Equivalent to magnesia	1·54

BEAUCE COUNTY.

An exposure of red marble, about three miles south of St. Joseph, close to the southern boundary of St. Joseph township, near the mouth of the Colway river, was visited and sampled. The outcrops can be traced across the main road for a distance of 1,600 feet. The widest exposure is about 25 feet. The stone is in places brecciated and veined with calcite. Masses of quartz occur in several places. The marble band is enclosed in red slates. Sample 209 is representative of this marble.

	Sample No. 209
Insoluble mineral matter	8·00
Ferric oxide	·43
Alumina	1·07
Calcium carbonate (*a*)	62·78
Magnesium carbonate (*b*)	26·85
(*a*) Equivalent to lime	35·16
(*b*) Equivalent to magnesia	12·85

Elsewhere in this county only impure limestones were observed.

STANSTEAD COUNTY.[1]

An old quarry on Magoon's Point was visited, and an average sample—No. 124—was obtained. The stone is light grey and close grained. The quarry has not been worked for a number of years.

	Sample No. 124
Insoluble mineral matter	2·68
Ferric oxide	·28
Alumina	·06
Calcium carbonate (*a*)	91·94
Magnesium carbonate (*b*)	5·20
(*a*) Equivalent to lime	51·50
(*b*) Equivalent to magnesia	2·49

[1] See Mines Branch Summary Report, 1914, p. 51.

DRUMMOND COUNTY.[1]

On lots 4 and 5, range I, Kingsey township, red limestone, similar to that of St. Joseph, outcrops over a considerable area. It, also, is closely associated with red slates. The stone is fine grained and tough, and in some places veined with calcite and quartz. No. 212 is an average sample.

	Sample No. 212
Insoluble mineral matter	16·48
Ferric oxide	·86
Alumina	1·80
Calcium carbonate (*a*)	71·10
Magnesium carbonate (*b*)	8·15
(*a*) Equivalent to lime	39·82
(*b*) Equivalent to magnesia	3·96

BAGOT COUNTY.[2]

A short time was spent about St. Dominique gathering additional data, and examining quarries that were not visited the previous season.

Levis Loisel operates a quarry on his farm, three quarters of a mile northwest of La Carriere. The stone is similar to that seen to the south of Bedford and in the neighbourhood of Philipsburg. It is a light bluish grey to fawn coloured, very fine grained marble, interveined with calcite. In the quarry, which is 10 feet deep, the thickest bed exposed measures 3 feet. Owing to distortion and irregular pitch, it would be difficult to obtain suitable stone for ornamental and masonry purposes. Crushed stone, only, is produced. Sample 216 is an average from this pit.

About half a mile southeast of Loisel's quarry, Elzear Lapointe is taking out similar stone for lime burning. Here, however, the beds are less disturbed, and large sound blocks for building purposes might be obtained. A short distance to the north the veined and brecciated character again prevails. The dip is 20° E., and the strike N. 30° E. Number 217 is an average sample from this quarry.

Both of the above workings would appear to lie to the west of the Champlain fault, but within the fault zone.

On the St. Rosalie road about two miles north of Lapointe's workings, and in the same general relation to the above fault, is an old quarry owned by Eusebe Cadoret. The beds, which are similar to those exposed in the foregoing openings, strike N. 55° E. and dip 25° to the south. Sample 214 is representative of the stone in this quarry.

At La Carriere the stone worked in the quarries to the east of the Champlain fault is dark blue, close grained, and lies in heavy beds containing argillaceous streaks. In one quarry, however, the stone is light bluish grey and marmorized similarly to that exposed west of the fault.

[1] See Mines Branch Summary Report, 1914, p. 47.
[2] See Mines Branch Summary Report, 1914, p. 47.

Sample No.	214	216	217
Insoluble mineral matter	2·22	2·54	1·80
Ferric oxide	·14	·17	·17
Alumina	·16	·13	·29
Calcium carbonate (*a*)	95·00	88·69	91·62
Magnesium carbonate (*b*)	2·80	6·43	5·91
(*a*) Equivalent to lime	53·20	49·67	51·31
(*b*) Equivalent to magnesia	1·34	3·08	2·83

MISSISQUOI COUNTY.[1]

Some time was spent this year in tracing the belt of high grade limestone from the southwestern corner of St. Armand township to a point about 13 miles to the north, on a line running about N. 20° E., and in examining in greater detail the rocks in the neighbourhood of Phillipsburg.

The following analyses are of the samples taken in this district:—

Sample No.	116	120	121	122	123
Insoluble mineral matter	13·30	1·52	2·04	7·80	20·00
Ferric oxide	·57	·14	·30	·43	
Alumina	1·79	·02	·06	·57	
Calcium carbonate (*a*)	48·30	95·71	93·39	53·21	
Magnesium carbonate (*b*)	34·15	2·71	4·11	38·25	
(*a*) Equivalent to lime	27·05	53·60	52·03	29·80	27·15
(*b*) Equivalent to magnesia	16·34	1·30	1·97	18·30	13·74

Sample 116 was taken on the face of the bluff overlooking Missisquoi bay, a short distance south of the wharf. The stone is a light grey dolomite, darker and much coarser grained than the Missisquoi marble, quarried a short distance to the north. At the top of the hill, it is capped by an almost white sandstone. In an easterly direction, dolomite again outcrops for a distance of 100 yards. This stone is represented by sample 122. The beds are overlain, or cut off, through faulting, by a narrow band of marble, which is exposed beside the road near the cemetery.

Half a mile to the south of the cemetery there is an extensive exposure of this marble on both sides of the road. Sample 121 was taken at this point.

Sample 120 was taken on top of the hill to the northwest of St. Armand station.

A buff-weathering, impure, dolomitic limestone was observed in a knoll a short distance east of the high calcium limestone[2] on Morgan's farm, lot 2, range IX, Stanbridge township. No. 123 is a sample of this rock.

SOULANGES COUNTY.

At various points along the upper reaches of the Soulanges canal, dolomitic limestone lies very close to the surface, being covered only by a light overburden of soil.

[1] See Mines Branch Summary Report, 1914, p. 43.
[2] See analysis No. 72, Mines Branch Summary Report, 1914, p. 44.

At one point near Coteau du Lac, Quinlan and Robertson, Ltd., formerly operated an extensive quarry for crushed stone. This pit is now abandoned and flooded.

Joseph Brisebois is working a quarry for road metal, a quarter of a mile east of the railroad bridge and half a mile north of the canal. The stone is hard, close grained and of a dark grey colour. It contains a small amount of shale between the beds, which range from one to three feet in thickness. Number 131 is an average sample of the stone.

	Sample No. 131
Insoluble mineral matter	6·90
Ferric oxide	1·14
Alumina	·26
Calcium carbonate (*a*)	53·03
Magnesium carbonate (*b*)	38·58
(*a*) Equivalent to lime	29·70
(*b*) Equivalent to magnesia	18·46

LABELLE COUNTY.

The crystalline limestones in the neighbourhood of Papineauville and Monte Bello were examined, and, wherever observed, were found to be impure and of no value for building or lime burning purposes. Near Papineauville, there are two extensive bands of this limestone having a northerly trend, and a length of eight or ten miles. (See Geological Survey of Canada, Map Number 121). The stone is bluish grey, due to the presence of numerous small flakes of graphite, and in places contains much serpentine and small mica flakes. Sample 225 was taken near the Papineauville wharf.

East of Monte Bello the crystalline limestone outcropping along the road contains many inclusions of siliceous rock, forming knobs and serpent-like ribs on the weathered surfaces.

On Presqu'ile Miller, half way between Papineauville and Monte Bello, there is an exposure of dark grey, stratified limestone, probably of Calciferous age. It occurs in beds from a few inches to three feet in thickness, and is fine grained. There is little opportunity for quarrying. Sample 226 represents about eight feet of strata.

	Sample No. 225	226
Insoluble mineral matter	23·24	8·00
Ferric oxide	—	·86
Alumina	—	·34
Calcium carbonate (*a*)	—	62·09
Magnesium carbonate (*b*)	—	28·36
(*a*) Equivalent to lime	38·34	34·77
(*b*) Equivalent to magnesia	4·10	13·57

OTTAWA COUNTY.

HULL.

In and about the city of Hull, limestone has been quarried for many years. Recently there have been few small quarries operated, the output being derived principally from large quarries working with modern appliances. Owing to the business depression at the present time, the production of this district, as elsewhere throughout the Province, has been materially reduced.

The following quarries were examined, and sampled:—

The Federal Stone and Supply Company is operating a large quarry located on the south side of Brewery creek, and bounded by Regent, Garneau, and Carillon streets. About 22 feet of limestone is being worked, the beds being capped in places by as much as 15 feet of overburden. The upper 9 feet is a fine grained, dark blue, thin bedded limestone, with shale partings. The succeeding 9 feet (see sample 227) is coarse grained, light grey, in fairly heavy beds, containing nodules of "flint" and a little shale.

The lower 5 feet, of which 228 is a sample, is free from shale and "flint." This rock occurs in heavy beds, and is light grey in colour, with a slight banding developed locally. The quarry, the principal product of which is crushed stone, is well equipped and operated by electric power.

The large quarry of Fleming Dupuis Supply Company, Ltd., at present closed, is located on the south side of Brewery creek, about opposite the cement mill. The stone here appears to be similar to that of the foregoing quarry. The plant is modern, and equipped to produce various sizes of crushed stone.

The quarries of Wright and Company, and T. G. Brigham were examined, reported upon in a previous year.

Dupuis et Fils produce crushed stone from a pit to the south of the Fleming-Dupuis quarry. The stone is similar to that of the upper beds of the latter quarry.

Napoleon Tremblay is operating a quarry on the west side of Chene avenue, north of Mountain road. About 17 feet of strata are being worked. The upper 12 feet are light grey limestone, fairly heavily bedded, and appear to be unconformable with the lower 5 feet, consisting of rather thinly bedded, fine grained, dark grey limestone, in which considerable shale occurs. The products are rubble, broken stone and shoddy.

On St. Louis street, a short distance from the Aylmer road, Rochon and Filiatreault are quarrying stone for dressing and shoddy. About 12 feet of strata are used. The stone is brownish to bluish grey, of medium grain, and occurs in beds averaging 1 foot in thickness. This stone is free from shale. Sample 230 is an average of the quarry face.

Sample No.	227	228	229	230
Insoluble mineral matter	2·66	2·24	1·44	·84
Ferric oxide	·14	·21	·25	·17
Alumina	·26	·53	·45	·33
Calcium carbonate (*a*)	95·18	94·48	90·85	97·52
Magnesium carbonate (*b*)	1·15	1·69	6·20	·79
(*a*) Equivalent to lime	53·30	52·91	50·88	54·61
(*b*) Equivalent to magnesia	·55	·81	2·97	·38

Besides examining quarries and limestone exposures, many lime kilns were visited, and data collected for embodiment in the final report on the limestones and lime industry of the Province of Quebec.

II

INVESTIGATION OF MISCELLANEOUS NON-METALLIC MINERALS.

Hugh S. de Schmid.

The greater part of the summer was devoted to the completion of reports on phosphate and feldspar: the data for which had been largely gathered in previous years.

In September, upon public announcement, by the Commission of Conservation of the discovery, by officers of the Commission, of phosphate rock in the neighbourhood of Banff, Alberta, I received instructions to proceed to Banff, with a view to ascertaining the economic importance of the find.

The results of the field work in this area have already appeared in a special Bulletin No. 12 (Catalogue No. 385) entitled "Investigation of a Reported Discovery of Phosphate in Alberta." The writer's examination showed that a well-defined phosphatic series exists in the Rocky Mountains, in rocks of Upper Carboniferous age; but that, in the Banff area at least, the beds are neither thick enough nor sufficiently high in phosphoric acid to be considered of any present economic importance. The average content of tricalcic phosphate in the principal bed found was 43·7 per cent. The large amount of silica present in this bed would preclude the rock being employed for the manufacture of superphosphate by the sulphuric acid method, though it may later prove suitable for treatment by one of the thermic processes that are constantly being devised to supplant the acid method.

The fact that a well-defined phosphate bed occurs in this district, is however, of importance, as pointing to a probable northerly extension into Canada of the rich Montana deposits, which occur in the neighbourhood of Butte, and indicating the possibility that thicker and richer beds may exist to the south and nearer to the International Boundary.

The latter part of the season was spent in visits to a number of mines and deposits of non-metallic minerals in Ontario and Quebec. These minerals include talc, feldspar, mica, phosphate, actinolite, fluorite, and celestite.

III

INVESTIGATION OF THE SAND AREAS IN THE PROVINCES OF QUEBEC AND ONTARIO.

L. Heber Cole.

In the summer of 1914, an examination of the sand and sandstones areas of the Province of Quebec was begun. Samples have been collected which are to be subjected to a series of laboratory tests to determine their suitability for use in the building trades, foundries, and glass manufacturing industry. This investigation was continued during the field season of 1915; the remaining districts tributary to the manufacturing centres in the Province of Quebec being visited; and the work was extended into the eastern part of the Province of Ontario. Owing to the fact that the writer was engaged most of the summer in supervising the installation of the various apparatus in the new Ceramic and Structural Materials Laboratories, most of the field work was carried out by Mr. J. Ross Taylor, who had acted as field assistant for the last two years. Mr. Taylor

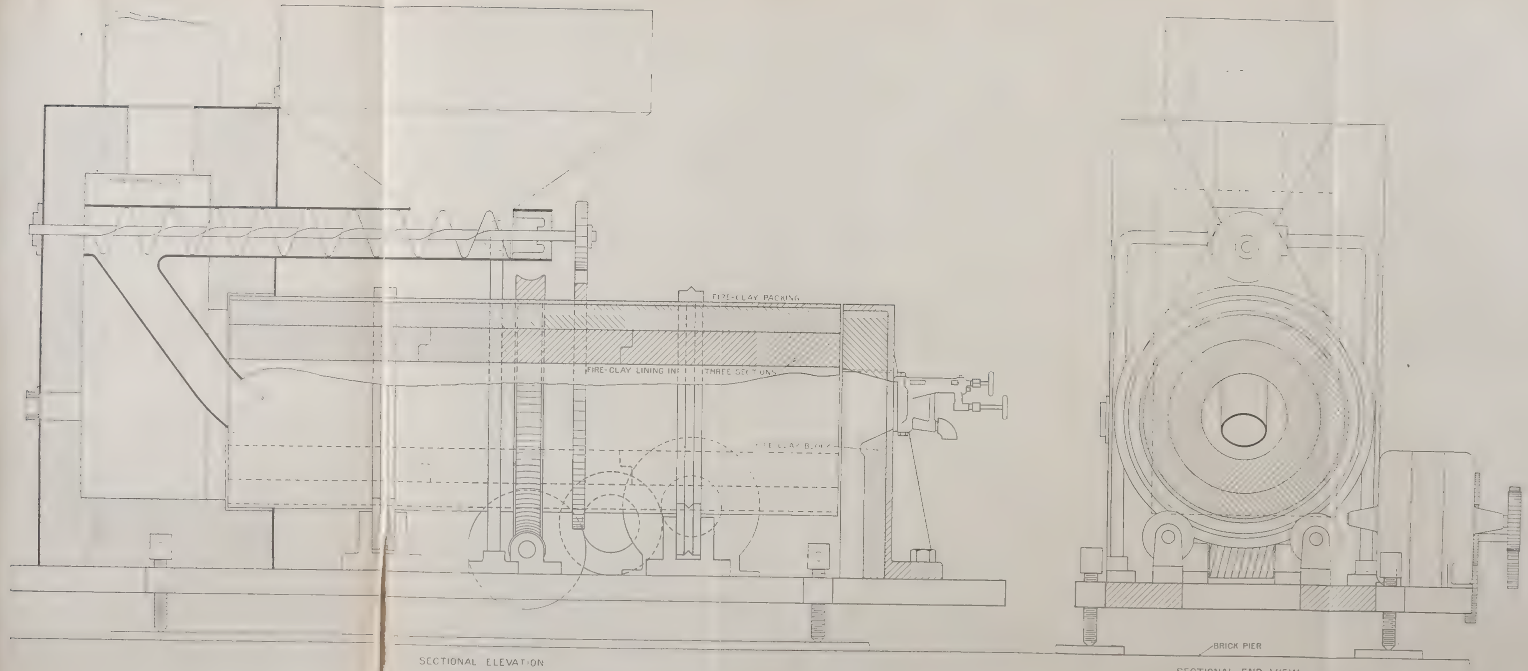

Fig. 1. Rotary kiln for cement burning tests, Mines Branch Testing Laboratory, Ottawa.

performed the duties assigned to him in a most painstaking and thorough manner.

The methods employed in the field were similar to last season, and consisted in mapping all the sand areas within reasonable distances of railways leading to commercial centres; thoroughly sampling the most important deposits; and carrying out preliminary field tests in order to obtain an idea as to the use to which the sand would most probably be suited.

The districts investigated were the eastern townships; the north shore of the Ottawa river from Lachute to Ottawa; and the district tributary to the Gatineau river—all in the Province of Quebec; together with that part of Ontario east of the railway from Ottawa to Brockville. Some 183 samples were obtained, and sent in to the office to be tested.

In order to carry out tests on these samples a laboratory for the proper testing of the materials required in concrete, etc., has recently been established in the basement of the Mines Branch building, Ottawa, and the following apparatus installed:—

One Olsen, automatic, cement testing machine, of 2,000 pounds capacity, motor driven, in which the load can be applied at a regular rate as may be desired: *i.e.*, at either 400, 600, or 800 pounds per minute, or any rate as specified. The reading is automatically recorded on beam and dial vernier. This machine can also be used for making compression and transverse tests.

One Olsen, hydraulic, compression testing machine, 200,000 pounds capacity, for compressive tests on cement, concrete, and brick specimens.

One Olsen, three-gang, soapstone immersion tank, size 6 × 3 feet, with provision for hot and cold water.

One cement mixing double table, with slate tops, and provision for waste bin in centre.

One Olsen, soapstone moist closet, with glass shelves, for storing cement briquets.

One complete set, 8″ Tyler, standard screen sieves.

One electrically operated *per se* testing sieve agitator, with semi-rotary and undulatory motion, to take sieves 8″ diameter and under.

Two electric hot plates 8″ × 13″, to be used on cement mixing table.

One Olsen standard vicat needle.

One washing apparatus for determining silt in sands.

One set Fairbanks platform scales, capacity 1,000 pounds.

One set Fairbanks agate bearing scales, capacity 15 pounds.

Necessary cement briquet standard gang moulds, and cube moulds.

One rotary, laboratory, cement burning kiln, 5″ diameter inside, by 3 feet long, with automatic feed, fired by gasoline; for testing the cement making qualities of raw materials. This machine is erected in the kiln room of the Ceramic Laboratory. See Fig. 1.

IV

INVESTIGATION OF BITUMINOUS SANDS OF NORTHERN ALBERTA.

S. C. Ells.

The work undertaken during the field season of 1915, falls into two divisions, viz:—

(1) Mapping of bituminous sands of Northern Alberta.
(2) Investigation of Alberta bituminous sand as a possible paving material.

1. *Mapping of Bituminous Sands of Northern Alberta.*

As pointed out elsewhere,[1] there is, in northern Alberta, a large deposit of bituminous or asphaltic sand. The areal extent of this deposit is not less than 750 square miles; but heavy overburden will prohibit actual development operations throughout the greater part of the area.[2] Other controlling factors are questions of transportation, and a lack of uniformity in the quality of the bituminous sand itself.

In view of the above considerations, the writer suggested that a topographical map be prepared, on which could be shown the extent and position of individual outcrops, as well as thickness and extent of overburden. Such a map would indicate those areas which could most advantageously be developed, and would also serve as the basis for a very approximate estimate of the total tonnage of bituminous sand commercially available.

The surface of the area underlaid by bituminous sand may be described as a peneplain, much of which is covered by swamp and muskeg. Through this plain the more important streams, excepting only the Clearwater and Athabaska, have cut narrow, notch-like valleys. On emerging above the rim of these valleys, one reaches the level country almost at once. With such a topography, outcrops of bituminous sand are thus confined to the slopes of older valleys, and to cut banks along present water courses. Consequently, in mapping the area adjacent to outcrops, it was possible, at the outset, to restrict within comparatively narrow limits the areas to be surveyed.

In May, 1915, a surveying party was organized and placed in the field at McMurray. The writer then returned to Edmonton, to supervise the construction of the proposed experimental pavement. On the completion of this work, the remainder of the season was spent with the field party near McMurray. Toward the end of October, surveying was discontinued, owing to snow.

During the past season, the principal valleys tributary to the Athabaska river were mapped. Stadia measurements, checked by base levels and by frequent ties with township and subdivision surveys, were depended on throughout. Manuscript plans, showing contours of twenty foot intervals, were drawn on a scale of one inch equals four hundred feet, and sets of advance copies have been prepared by photographic reductions. A typical sheet of one of these maps is reproduced as Fig. 2, and illustrates, topographically, the manner in which the deposits of bituminous sand occur.

The valley of the Athabaska itself still remains to be surveyed. On the completion of the whole work, it is proposed to compile the various individual surveys as a single map sheet. The following constitutes a summary of topographical mapping completed during 1915. Copies of maps of the streams mentioned are now available.[3]

Name of stream	*Approx. length*	*Approx. area*	*No. of outcrops indicated*
Horse river..................	5·53 miles	2·5 sq. miles	17
Hangingstone river............	4·39 "	2·5 "	15
Clearwater river..............	17·05 "	34·0 "	10
Christina river...............	10·45 "	9·5 "	30
Steepbank river...............	11·14 "	7·0 "	34
Moose river...................	16·89 "	6·5 "	76
McKay river...................	25·76 "	22· "	94
	91·21 "	84·0 "	276

[1] Preliminary Report on the Bituminous Sands of Northern Alberta, by S. C. Ells.
[2] In making this statement it is assumed that excavation of the bituminous sand will necessarily take the form of open cut operations.
[3] January 1st, 1916.

Fig. 2. Section of topographical map, illustrating typical mode of occurrence of bituminous sand deposits in northern Alberta. All streams tributary to the Athabaska river in the McMurray district have been mapped in this manner. The maps were originally drawn on a scale of 400 feet to 1 inch, but have been reduced to present scale, 1,000 feet to 1 inch. Outcrops of bituminous sand are almost altogether confined to slopes of older valleys, and to cut banks along present watercourses. Elsewhere the surface of the country is level, and represents a plain. On the maps, outcrops of bituminous sand are indicated to scale at certain points. It should, however, be remembered that these outcrops represent a single deposit which is practically continuous throughout the whole area.

2. *Investigation of Alberta Bituminous Sand as a possible paving material.*

Following a preliminary examination of the deposits of bituminous sand undertaken in 1913, the writer suggested that a section of experimental pavement be laid. It was felt that such a pavement would illustrate in a practical manner the value that should attach to the Alberta deposits as the possible source of a suitable paving material. During 1914, therefore, a quantity of the bituminous sand was mined, and shipped to Edmonton, where, the past season, this material was laid as a pavement, comprised sections of three types of surfacing, viz., sheet asphalt, bitulithic, and bituminous concrete.

As a site for this pavement, a section of Kinnaird street immediately south of Alberta avenue, Edmonton, was selected. The traffic along this part of Kinnaird street may be classed as heavy, hence will give the pavement a fairly severe test. Apart from a considerable volume of fast automobile travel, it includes vehicles which carry loads up to eight and ten tons.

The following is a very brief outline of the procedure followed in laying the above pavement.

It should be remembered that deposits of bituminous sand in northern Alberta may be roughly grouped in two classes, viz:—

(a) Deposits in which bitumen is combined with a coarse mineral aggregate.
(b) Deposits in which bitumen is combined with a fine mineral aggregate.

The trial shipment of bituminous sand shipped from McMurray to Edmonton comprised both fine grained and coarse grained varieties.

A study of preliminary analyses at once indicated the necessity for careful manipulation of the crude material both before and after it was placed on the street.

1. *Manipulation of Bituminous Sand before being sent to street.*

For convenient reference, abridged analyses[1] of the crude bituminous sand may be stated as follows:—

	Coarse bituminous sand	*Fine bituminous sand*
Asphalt cement	12·0%	16·0%
Passing 200	2·7%	6·0%
" 100 screen, retained on 200 screen	4·5%	54·6%
" 80 " " 100 "	0·7%	15·6%
" 50 " " 80 "	6·8%	23·0%
" 30 " " 50 "	22·0%	0·6%
" 20 " " 30 "	34·2%	
" 10 " " 20 "	27·2%	
Oversize	1·6%	

Penetration of extracted bitumen.

Penetration at 115° F., 100 grams, 5 secs.,	too soft
Penetration at 77° F., 100 grams., 5 secs.,	too soft
Penetration at 77° F., 100 grams, 1 sec.,	130° Dow
Penetration at 32° F., 100 grams, 5 sec.,	25° Dow
Ductility at 77° F.,	100 cm. +
Volatile 160° C.—5 hours (Using New York testing oven),	11·2%
" 205° C.—5 " " " " "	14·2%
" 250° C.—4 " " " " "	18·8%

[1] For complete analyses see App. VII, Preliminary Report on Bituminous Sands of northern Alberta.

From a consideration of the above analyses of the crude material, three outstanding features are at once apparent:—

(1) High penetration of asphalt cement (with high percentage volatile fractions).
(2) Unbalanced mineral aggregates.
(3) Excessive percentage of asphalt cement.

The effect of unduly high penetration was modified by partial distillation of the more volatile fractions. The unbalanced aggregates of coarse and of fine bituminous sand were partially corrected by combining the two in a proportion of two of fine to one of coarse. In the case of the sheet asphalt mix, the resulting aggregate was further modified by the addition of clean and graded sand; but in the case of the bitulithic mix, by the addition of clean sand and graded crushed gravel. In the case of the bituminous concrete, fine grained bituminous sand only was used, which was further modified by the addition of graded crushed gravel, and clean sand. This manipulation also reduced the somewhat high percentage of asphalt cement present in the original material, to the final percentage desired in each case.

In heating and mixing the materials, a heated rotary mixer[1] (Plate IV) was used. This mixer consists essentially of a revolving, jacketted drum, set on trunions above a fire-box, and connected to the engine by shafting and gears. The inner surface of the mixer drum is fitted with baffles so arranged that a thorough mixing of charged materials is assured. Convenient charging and dumping facilities are provided.

In the experimental work here referred to, the mixer used proved fairly satisfactory. In heating and mixing Alberta bituminous sand on a commercial scale, however, the limited capacity of the mixing drum would render its use impracticable. A Torpedo mixer[2] somewhat similar to those used by the City Street Improvement Company of San Francisco, should give satisfactory results when a large output is required.

In actual operation, and prior to charging, the drum was usually preheated to a temperature of 250°—300° F. The bituminous sand was then wheeled in barrows to the loading platform, and the drum charged. During the first period of heating, the charging opening of the drum was kept closed by means of a damper. When, however, the bituminous sand had reached the desired temperature, the heat was turned off and the damper removed. The mix was then allowed to remain in the drum for a further period of 8 to 10 minutes, during which time the lighter hydrocarbons passed off freely as vapor.

In adding crushed rock—as in the case of bituminous concrete and bitulithic —it was found that a better bond resulted when the rock was charged at a drum temperature not above 300° F. In adding new sand, however, as in the case of sheet asphalt, the sand was usually added after the crude bituminous sand had attained a temperature of 380°–400° F. In either case it was found that a period of ten minutes was sufficient to permit of all materials becoming thoroughly mixed. The following abridged record sheets indicate average periods of heating, range of temperatures, weights, and composition of mixes, etc.

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[1] Manufactured by Rapid Heated Mixer Co., Grand Rapids, Mich.
[2] Preliminary Report on Bituminous Sands of Northern Alberta, by S. C. Ells, pp. 59–60.
Torpedo mixers are built by the Columbia Machine Works, 215 Spear Street, San Francisco, and by the Schneider Engineering Works, 1414 Fifteenth Street, San Francisco.

Charge Sheet of Mixture Averages,

Charge	Sheet Asphalt		Bituminous Concrete		Bitulithic	
Fine grained bituminous sand	726 lbs.	(52%)	755 lbs.	(58%)	480 lbs.	(35%)
Coarse " " "	363 "	(26%)			240 "	(17·5%)
10/20 clean sand			52 "	(4%)	26 "	(1·9%)
30/50 " "	114 "	(8·2%)				
50/80 " "	77 "	(5·6%)				
Dust (Portland cement)	100 "	(7·2%)			26 "	(1·9%)
Crushed gravel (crusher run), max. ½ in			388 "	(29·8%)		
" " 1/10"–1/8"					16 "	(1·2%)
" " 1/8" –1/4"					70 "	(5·1%)
" " 1/4" –1/2"			107 "	(8·2%)	156 "	(11·4%)
" " 1/2" –3/4"					248 "	(18·1%)
" " 3/4" –1					108 "	(7·8%)
Total weight of charge	1,380 "		1,302 "		1,370 "	

In each case the crude bituminous sand alone was heated for a period of from 20 to 30 minutes. The clean sand, or the clean sand with crushed gravel, was then added. This addition caused the temperature of the mix to fall 20°–30°, and five to eight minutes were required for the mix to regain its former temperature. The damper was then removed from the mixer drum and vaporization of the lighter hydrocarbons—indicated by volumes of oil vapour—proceeded freely. To some extent, the colour of the vapour indicated the progress of distillation, but after a period not exceeding ten minutes the contents of the drum were discharged into the wagon. The average time required for the treatment of a 1,400 pound batch (equivalent to approximately 7 square yards of 2″ surface) was thus rarely less than 40 minutes, and it is doubtful whether much better average results could be hoped for with the equipment used. The temperature of the mix when discharged into the wagons usually ranged from 380°–410° F.

The following are abridged analyses[1] of samples taken from wagons:—

	Sheet Asphalt	*Asphalt Concrete*	*Bitulithic*
Through 1″ and retained on 10 mesh			34·7%
Through ½″ and retained on 10 mesh		35·3%	
Retained on 10 mesh	0·5%		
Through 10 mesh, retained on 20 mesh	7·0%	4·0%	6·7%
" 20 " " 30 "	12·5%	0·8%	8·1%
" 30 " " 50 "	13·5%	0·3%	
" 50 " " 80 "	13·7%	4·2%	
" 80 " " 200 "	33·0%	42·1%	37·0%
" 200 "	9·0%	3·9%	5·2%
Asphalt cement	11·3%	9·1%	8·1%
	100·5%	99·7%	99·8%

Penetration of A.C. at 115° F., 100 gr. 5 sec.	too soft
" " 77° F., 100 gr. 5 "	too soft
" " 77° F., 100 gr. 1 "	120° Dow
" " 32° F., 100 gr. 5 "	19° Dow
Ductility " 77° F.,	100 + cm.
" " 115° F.,	100 + cm.
" " 32° F.,	100 + cm.

Penetration of the asphalt cement extracted from different batches, after heating, varied considerably, the lowest being 85° Dow, (77° F., 100 grams, 5 secs.) Owing to engine trouble, the mix, from which this particular sample was taken, was held in the mixer for upwards of one hour. The consistency of this sample indicates the practicability of attaining results that equal those where California oil asphalt is used.

The consistency of the asphalt cement extracted from certain other samples indicates insufficient heating. This is undoubtedly a weakness. It is, however, not believed that it will result in the disintegration of the wearing surface, although the surface may mark excessively in warm weather. The readiness with which a soft pavement takes up the surface dust carried on it, as well as the evaporation of the lighter oils, will result finally in curing the defect. The usual result is that such a pavement is criticised severely, but ultimately outwears its neighbours. With a modified type of mixer expecially adapted to handling the Alberta bituminous sand, there is little doubt but that the lack of uniformity and defects noted above can be corrected.

[1] All analyses are based on extraction by centrifuge.

In the balancing of the various aggregates, the above analyses indicate room for improvement; and in this respect there should be no real difficulty in making desired modifications. The penetration of the asphalt cement is high. Within reasonable limits and with a properly balanced aggregate this does not necessarily indicate a source of weakness.

Total cost per ton..$6.20

2. *Manipulation of bituminous sand after being sent to street.*

The subgrade upon which the base was laid is composed of typical prairie loam, on strong blue clay. After grading had been completed, this was thoroughly compacted by rolling with a 7-ton roller. The finished grade showed a maximum gradient of 1%.

A 6″ concrete base (composed of 1 part Portland cement, 3 parts clean, sharp sand, and 6 parts crushed gravel) was laid on the sub-grade. In order that this base might thoroughly set, an interval of 11 days was allowed to elapse before the asphalt wearing surface was added.

The sheet asphalt was given a compacted thickness of 2¼″, and was laid on an open binder, compacted to 1½″. The bitulithic and bituminous concrete were laid directly on the concrete base, and were given a compacted thickness of 3″. A thickness of 2½″ would probably have given equally as good results. The width of the finished pavement was 18′.

No permanent curbs or other lateral support was available. Consequently tamarac headers, 4″ × 6″ were used, and were secured to stakes, 4″ × 6″ × 2′ 6″. Headers of this type have been extensively used in Edmonton, and have given general satisfaction.

The wearing surface mixture reached the street at an average temperature of 325° F., though the temperature of occasional loads was 350° F. It was immediately spread with hot shovels and hot rakes.

Owing to the somewhat light nature of the contained asphalt cement, it was found necessary to exercise care in rolling the bituminous sand surface mixtures. The best results were obtained by first rolling with a light (15 pounds per linear inch width of tire) hand roller almost immediately after the material had been spread. As soon as the temperature permitted—usually within three hours—a small quantity of Portland cement was sprinkled, and the surface thoroughly compacted by means of a 7-ton roller (250 pounds per linear inch width of tire).

In the case of the bituminous concrete and bitulithic, the usual flush coat, with ¼″ stone screenings, was spread upon the surface, and all superficial voids filled.

Conclusions.

The experimental pavement (Plate III), referred to above, was opened to traffic on Aug. 26, 1915, and up to the present time, (Dec. 20), is in a satisfactory condition. It is obviously quite possible that defects may develop in this initial work with new and untried material. Nevertheless, there are strong indications that, with minor modifications in manipulation, Alberta bituminous sand can be successfully adopted as a basis for satisfactory asphaltic wearing surfaces.

From a comparative study of cost data based on the use of Alberta bituminous sand and of imported asphalts, it appears that the application of the former in the crude state will be restricted within comparatively narrow limits in Western Canada. Indeed, extensive development of the McMurray deposits will probably depend on the commercial application of an extraction process whereby the bitumen can be marketed in a more or less pure form. Such a process would doubtless ensure for the McMurray product a wide market, not only as a paving material, but in other recognized applications for high grade bitumen.

At various places in the United States during the past twenty-five years, the commercial extraction of bitumen from bituminous sands and sandstones has been attempted.[1] Owing to various recognized causes, none of these attempts have met with commercial success. Nevertheless, in view of the various factors that must be taken into account in considering past attempts, the writer considers that, under favourable conditions, commercial extraction, as applied to the McMurray deposits, will be found practicable. Further, it should be remembered that, owing to freight and other charges on imported asphalts, extraction in Alberta would be on a much more favourable basis than has, for example, been the case in California where competing residuum can be sold at a very low figure.[2]

It is of importance to note that, in December, 1915, grading along the Alberta and Great Waterways railway was practically completed as far as the proposed terminus at McMurray townsite. In descending into the Clearwater valley near McMurray, railway cuttings have been made at three points in the bituminous sand itself. Within a radius of one mile of the terminus of the road, a number of other outcrops are readily accessible. It is expected that track-laying and ballasting will be completed by January 1, 1917. The distance from Edmonton to McMurray over the new railroad will be appoximately 305 miles.

Reference has been made[3] elsewhere to the occurrence in the McMurray district, of certain of the higher grade clays. During the past season the following additional samples were collected:—

No. 1. Sample from outcrop near shore of Athabaska river, and 150 yards south of Well No. 1, Athabaska Oils, Ltd., (R. 11, Tp. 96, sec. 2 w. of 4th.).

Nos. 2 and 3. From first forks on Annes creek, one half mile from mouth. (R. 9, Tp. 89, sec. 27 w. of 4th.

Nos. 4 and 5. Samples from cuttings along Alberta and Great Waterways railway, (R. 7, Tp. 88, sec. 21 w. of 4th.). These two samples are from the Clearwater shales, and represent large deposits immediately adjacent to rail transportation.

Mr. Joseph Keele, chief engineer of the Ceramic Division of the Mines Branch, has examined the above samples, and has reported as follows:—

Lab. No. 371. Clearwater shale, from Sta. 284, A. and G. W. Ry. Soft, dark grey shale, which requires 34 per cent of water in tempering. It is exceedingly plastic, and forms a smooth pasty mass, which is difficult to work.

It cracks badly in drying, with a shrinkage of 11 per cent. It burns to a red colour and fairly hard body at low temperature, and fuses at cone 3. Owing to its high shrinkage and tendency to crack in drying, this clay is not recommended for the manufacture of clay products.

Lab. No. 372. Clearwater shale, from Sta. 328, A. and G. W. Ry. Soft greyish shale, exceedingly smooth and plastic when tempered with water, but rather stiff to work.

The small test pieces made from this shale did not crack in drying, but large sized pieces may give trouble in drying. The shrinkage on drying is rather high, being about 10 per cent. The clay burns to a hard, red body at 1,800° F., and fuses at cone 3.

If mixed with about 30 per cent. of sand, this clay may be suitable for common brick or hollow ware.

Lab. No. 373. Clearwater shale, from Sta. 349, A. and G. W. Ry. Same properties and uses as No. 372.

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[1] Appendix III. Preliminary Report on the Bituminous Sands of Northern Alberta.
[2] Present price (1915) of "D" grade asphalt at Edmonton, Alberta, is $25 per ton. The same material can be purchased in San Francisco at $9–$10 per ton.
[3] Notes on Clay Deposits near McMurray, Alberta, S. C. Ells.

Lab. No. 374. Dark grey, soft shale, from Annes creek. A very stiff, waxy clay when wet; difficult to work, and dry. It puffs and cracks in slow burning at low temperatures, so that it is useless for the manufacture of clay products.

Lab. No. 375. Hard, light grey shale, from Annes creek. This shale requires 37 per cent of water for tempering. It is highly plastic, and forms a stiff, pasty, wet mass. Small bricklets made from it crack while drying, and show a shrinkage of 11 per cent when thoroughly dry. The clay burns to a light red, dense body at 1,800° F. If mixed with sand it might be made into common brick, but the drying would be sure to give trouble.

Lab. No. 376. Grey clay, from property of Athabaska Oils, Limited, situated on east bank of Athabaska river, near No. 1 derrick. This is a highly plastic, smooth clay, rather stiff, but has good working qualities. Its shrinkage in drying is 7 per cent. It burns to a dense, steel-hard, buff coloured body at 2,000° F., and does not fuse until about cone 13 (2,534° F.). This is a stoneware clay, suitable for the manufacture of pottery such as jugs and crocks, or for sewer pipe, but it is not refractory enough to be considered a fireclay. This is the only really useful clay in the above series of samples.

Prior to the writer's departure from McMurray in October, a quantity of bituminous sand was mined and sacked. Some twenty gallons of more or less pure bitumen or mineral pitch were also secured and sealed in suitable containers. This bitumen was taken from four of the so-called "tar springs", and represents the average character of such material. Subsequently, the above shipment was hauled by sledge 150 miles to the end of steel of the Alberta and Great Waterways railway and thence forwarded to the Mines Branch Testing Laboratory at Ottawa. During the coming winter, the material will be utilized in an attempt to determine a possible commercial process for extracting the bitumen from the associated silicious material aggregate. The results of this investigation will be followed with the interest which the real importance of the work demands.

In 1913, an interesting sub-variety of bituminous sand was found by the writer on Hangingstone river. In ascending this stream, the best exposure of the material in question occurs in the upper part of the first outcrop on the west bank. (N.E. $\frac{1}{4}$ sec. 9, Tp. 89, R. 9 w. of 4th M.). From information available, it appears that this is the first occurrence of the kind that has been recognized on this continent.

The material consists of silica sand and fresh water shells, the whole being cemented together by a rather soft bitumen. In an average sample, the proportion of each constituent was determined as follows:—

Sand—(90 per cent. of which passes a 50 mesh, and is retained on a 200 mesh)	64·7	per cent.
$CaCO_3$ (present in form of fresh water shells)	20·3	"
Bitumen	15·0	"
	100·0	"

Apart from the associated shells, the material closely resembles the bituminous sand so common throughout the McMurray district.

The available tonnage of the material does not appear to be great, though this has not yet been finally determined. A full section of the cut-bank in which the occurrence was noted is, approximately, as follows:—

High grade bituminous sand	70′	thick
Low grade bituminous sand (banded)	33′	"
Bituminous sand carrying shells	5′	"
Low grade bituminous sand (dry and banded)	22′	"
Overburden	45′	"
	175′	

In ascending Hangingstone river above this outcrop, pieces of shell-bearing float were found for upwards of 1¼ miles.

Special applications of the material have not as yet been determined. It is, however, probable that it would form a satisfactory basis for some form of mastic.

A number of the shells were separated from the aggregate, and through the courtesy of Mr. R. G. McConnell, Deputy Minister of Mines, were submitted to Dr. E. M. Kindle, Invertebrate Paleontologist of the Geological Survey. In referring to these shells, Dr. Kindle writes as follows:—

The specimens of gasteropod shells from the bituminous sands near McMurray which you transmitted to me for determination appeared to represent undescribed species and were referred to Dr. T. W. Stanton, who writes regarding them as follows:

Apparently only two species are represented and they are both undescribed. The larger, smooth form is a *Campeloma*. The other species, represented by only three small individuals, probably all immature, is a Melanoid shell possibly belonging to the genus *Pachymelania*. The oldest record of *Campeloma* in America is in the Bear River formation of Wyoming which lies at the base of the Cretaceous. The genus *Pachymelania* was described from the same formation. It should not be inferred from this that the "tar sand" is to be correlated with the Bear River formation, but the occurrence of these two genera in the "tar sand" is not surprising since the formations have approximately the same position in the geological column."

It follows from the above that while the evidence of these shells is not sufficiently clear to either confirm or oppose the early reference of these beds to the Dakota by McConnell they indicate an early Cretaceous age for them.

BUILDING AND ORNAMENTAL STONES OF SASKATCHEWAN AND ALBERTA.

Dr. W. A. Parks.

Under instructions from the Director of the Mines Branch, I spent ten weeks of the summer of 1915: May 10 to July 17, in Saskatchewan and Alberta, securing data for the completion of Vol. IV of the Report on the Building and Ornamental Stones of Canada.

The actual building stone industry of the two provinces is confined to the sandstones of the Paskapoo formation, which are quarried at points on the Crowsnest branch of the Canadian Pacific railway, on the main line to the westward of Calgary, and at a number of places along the line of railway between Edmonton and Macleod, more particularly in the immediate vicinity of Calgary.

The stone from these quarries is a soft and easily worked freestone which has been used for many monumental structures as well as for numerous business blocks and residences in the chief cities and towns of Alberta.

The more important areas in which the Paskapoo sandstone has been quarried are as follows:—

Monarch area on the Old Man river west of Monarch station on the Crowsnest line of the Canadian Pacific railway. The superficial stone in the quarries of this area is of buff colour but the product from the deeper workings is distinctly blue.

Macleod-Brocket area including quarries at Brocket and Pincher on the Crowsnest line, and in the Porcupine hills to the west of Macleod. The stone is of grey colour with a slight cast of brown.

High River area including abandoned quarries on Highwood river and a few scattered quarries to the east of the railway. The stone is mostly of a greyish-yellow type and has been very little exploited.

Sandstone area comprising a few unimportant quarries near the village of Sandstone on the Calgary-Macleod branch of the Canadian Pacific railway. Bluish and greyish-yellow stones are shown in these quarries.

Calgary area including quarries in the immediate vicinity of Calgary, westward to Brickburn, and northward to Beddington. The typical stone is of yellow or buff colour; it is responsible for the characteristic appearance of the business section of the city of Calgary.

Glenbow-Cochrane area embracing quarries at Keith, Glenbow, and Cochrane on the main line of the Canadian Pacific railway west of Calgary. The stone is of grey to yellow colour but it is never so distinctly yellow as the typical Calgary stone.

Red Deer area with small and unimportant quarries near Red Deer, Didsbury, and Innisfail. The stone is mostly of a greyish type.

Entwistle area on the main line of the Grand Trunk Pacific railway west of Edmonton. Blue, buff, and grey stone occurs here, but it seems to be too soft and friable for a satisfactory building matrial.

The strata exposed in the various quarries show great differences in grain and in the degree to which "reediness" is developed. In nearly all cases the marketable stone is obtained from the outer weathered zone, and hard unmarketable material is always encountered at very moderate depths. On this account it is unlikely that a permanent quarrying industry can be located at any one point.

The average commercial stone is soft and very easily worked: it dresses well to a smooth finish and is susceptible to fine carving.

The following table indicates the average of the more important properties of nine of the best known commercial stones:—

Specific gravity	2·678
Weight per cubic foot, lbs	137·54
Pore space, per cent	17·66
Crushing strength, lbs. per sq. in., dry	8,306·
Crushing strength, lbs. per sq. in., wet	5,613·
Crushing strength, lbs. per sq. in., wet after freezing	4,065·
Transverse strength, lbs. per sq. in	521·
Shearing strength, lbs. per sq. in	531·

During the summer of 1915, the actual production from any of the quarries was negligible: this lack of activity was in part due to the depression consequent on the war, and in part to the factors enumerated below:—

1—The active competition of other stones, particularly Tyndall and Indiana limestone.

2—The high rate of wage demanded by stonecutters.

3—The great loss in quarrying due to the variable nature of the stone and to the presence of "hardhead" and unfavourable streaks.

4—The impossibility of disposing of any product of the quarry except the best grade of soft freestone. There is no demand for rubble or for crushed stone.

5—The lack of confidence on the part of contractors in the ability of quarry operators to supply stone to order.

6—The failure of the good stone at depth.

Sandstones occur in other formations than the Paskapoo, but, in no instance, has any serious quarrying been attempted. The formations yielding sandstone are as follows:—

Fort Union formation of the Eocene system, presenting very soft sandstones of no promise in the Souris valley of southern Saskatchewan.

Paskapoo formation, already considered.

Edmonton formation showing very soft argillaceous sandstones in eastern Alberta and somewhat more indurated types in the foothills. The formation presents little or no possibilities as a producer of building stone.

Belly River formation represented by very soft sandstones in the Milk River region of southern Alberta, by somewhat harder but not very promising types in the foothills, and by the Allison Creek formation of the Crowsnest region. No stone has been raised from the formation and the possibility of production is not encouraging.

Dakota formation represented by hard greenish or greenish-blue sandstones at many points along the foothills and on the back slopes of the outer or eastern ranges of the Rocky mountains. The stone is very hard and subject to change of colour on weathering, but it is a possible building material for rough purposes. The formation was examined on the Crowsnest line of the Canadian Pacific railway, on the main line of the Grand Trunk Pacific railway, near Mountain Park colliery, and on the McLeod river to the west of that district.

Kootenay formation presenting numerous narrow bands of very hard sandstone of poor weathering properties. Some of this stone might be used locally but there is no hope of a quarrying industry.

Limestones occur in enormous amount in the Cambrian, Devonian, and Carboniferous formations of the great ranges, of the eastern Rocky mountains. Although some stone has been raised from these formations for lime and cement making, there has been no attempt to quarry the limestone for structural purposes. For the most part, it is too hard and brittle and too much cut by fractures to make quarrying commercially possible. The most promising stone occurs in the crinoidal layers of the Upper Banff limestone: a small amount of this stone has been used for building purposes at Blairmore and Banff. The hard black stone

of the Lower Banff limestone is susceptible of a good polish and, if it could be secured in pieces of sufficient size, it would have an application as a black marble.

The Upper Banff shale of Permo-Triassic age presents certain bands of argillaceous limestone which, on account of their even bedding and jointing, are capable of easy quarrying. This type of stone has been quarried near Banff and has been used in the construction of the Canadian Pacific railway hotel and the Government swimming pool at Banff. The stone is very hard and black when freshly quarried, but it is subject to serious deterioration in colour on weathering.

The hard Rocky Mountain quartzite is accessible at many places and could be used for purposes of rough construction; its extreme hardness, however, would render any attempts at cutting commercially impossible.

A subdivision of the Cambrian series known as the St. Piran quartzite has been quarried on Lake Louise for use in the chalet. The stone is a hard quartzite which possesses a distinct value on account of its unique colouration in shades of pink and white.

A hard conglomerate schist from the Corrall Creek formation of the Pre-Cambrian system is exposed near Laggan; this stone has been quarried to a very small extent for use in bridge piers along the line of railway.

Marble occurs in the Vermillion pass and at the base of Mount Geikie. The former is a medium grained white variety and the latter a pink and white banded type. The commercial possibilities of these deposits have not yet been proved.

Slates occur in abundance in the Pre-Cambrian and Cambrian systems, but as far as is known, they are incapable of yielding commercial material.

Granites are not known in the Rocky mountains of Alberta but a series of volcanics occurs in the region of the Crowsnest pass; these rocks do not seem to present any possibilities as ornamental stones.

It is apparent that the examination of the vast region presented by the eastern ranges of the Rocky mountains could be made only by selecting typical localities of easy access. An attempt was made to examine a few locations in each of the formations which make up the great ranges and to describe the rocks as indicative of the possibilities of production.

ORE DRESSING AND METALLURGICAL DIVISION.

G. C. MacKenzie,
Chief of Division.

I

PROGRESS REPORT.

During 1915, the Ore Dressing and Metallurgical Laboratories have devoted a great deal of time and attention to the problem of the concentration of molybdenite ores. Very early in the year our attention was directed to a circular issued by the Imperial Institute, from London, England, stating that the mining and milling of molybdenum ores would undoubtedly be an important factor in the production of war munitions, more particularly as it was expected that the supply of tungsten ores would be inadequate to meet the demand of certain manufacturers of special steels.

Mr. W. B. Timm was sent out into the field to inspect several of the more promising prospects of molybdenite ores, and at the same time secure large samples of molybdenite ores for purposes of experimental testing and concentration. On Mr. Timm's return to Ottawa with his samples, experimentation was forthwith begun. The samples secured by Mr. Timm consisted of pregmatic dike material, containing pyrrhotite, pyrite, and molybdenite associated with biotite, pyroxene, quartz, feldspar, and other associated minerals.

The first attempts on concentration consisted in sufficient crushing to free the molybdenite, followed by careful sizing and jigging. It was, however, very quickly discovered that nothing could be expected by this method, the more nearly rounded or thicker pieces of molybdenite reporting with the pyrite and pyrrhotite as a jig concentrate, whereas the lighter molybdenite invariably reported with the lighter gangue minerals in the jig tailings.

The electrostatic separation was then tried with results that were more encouraging in preliminary work, but it was found exceedingly difficult to make a clean high grade concentrate, as pyrite, pyrrhotite, and mica would invariably report to some extent in the electrostatic heads.

Table work was attempted, and while there was no difficulty in eliminating mica, pyrite and molybdenite invariably reported so closely together that a commercial separation was evidently out of the question.

Experimentation was then directed in an effort to perfect a wind machine, in which advantage was taken of the fact that with any given screen size where the particles of molybdenite were of equal area with the particles of pyrrhotite, pyrite, and other associated gangue, but their cross section area being considerably less, the mineral always assumed a flaky condition, similar to mica or graphite. Taking advantage of this characteristic, a wind machine was built, consisting of two drums, over which passed an endless belt, made of fine wire screen, air being drawn through the belt into one of the drums by means of a suction fan. The crushed and sized mineral was then fed upon the screen belt, and the latter driven in the direction of the drum, under suction. It was found that the larger flakes of molybdenite adhered to the belt and were thereby carried away from the more rounded particles of gangue. The separation, however, was incomplete inasmuch as it was found impossible to reduce all particles of molybdenite into scales thin and flaky enough to be influenced by the suction.

The attention of the staff of the laboratories was then directed to the possibilities of flotation. Two distinct methods were tried (a) oil flotation by the

mineral oil separation process, and (b) ordinary water film flotation. The mineral oil separation process was found to yield a concentrate containing all the sulphides in the original crude, and it was also found rather difficult to make clean tailings. Nevertheless, by repeated frothings clean tailings were finally produced. The concentrate, however, required roasting at a low temperature in order to oxidize the pyrite and pyrrhotite, and then this roasted concentrate was refloated and yielded a fairly high grade molybdenite concentrate with a considerable portion of middlings to be returned. The water film flotation method from the start indicated the favourable possibilities presented by this method of separation. The basic principle has, of course, been known for a great many years, and descriptions of apparatus used to float mineral particles may be found in many of the old technical journals. A great deal of time was spent in experimentation as to the proper method of introducing the ore to the surface of the water. The method of dropping from a plate or shaking tray was first tried and then disregarded in favor of feeding from an inclined slide, this in turn giving way to a roller belt feed. The machine as completed to-day resembles in some particulars the machine placed on the market by Henry E. Woods of Denver, but the departmental separator has distinctly wider latitude than the American machine and is capable of treating a wider variety of ores, more particularly the sulphide ores of eastern and central Ontario.

A list of the ores tested throughout the year is given below.

II

LIST OF ORES TESTED, 1915.

The following ores have been tested, and reports made thereon, during the calendar year 1915:—

No. of Test	Ore	Locality	Shipper	Weight Tons	Weight Lbs.
34	Molybdenite.........	Addington, Ont........	John Cameron, Ottawa, Ont........		286
35	Molybdenite.........	Renfrew, Ont.........	C. G. Ross, Ottawa....	10	100
36	Molybdenite.........	Mountain Grove, Ont.	G. M. Macdonnell, Kingston, Ont.......		238
37	Zinc................	Slocan Star Mine, Slocan, B.C.........	Oscar V. White, Slocan, B.C...............		465
38	Molybdenite.........	Chisholm Mine Co., Addington, Ont......	A. M. Chisholm, Kingston, Ont.......	18	047
39	Molybdenite.........	Wakefield, Que........	J. D. Roche, Montreal, Que.......		150
40	Molybdenite.........	Renfrew Molybdenum Mines, Ltd., Renfrew, Ont...........	Renfrew Molybdenum Mines, Ltd., Mt. St. Patrick, Ont........	16	210
41	Iron, Magnetite, Hematite and Quartz...	Bathurst, N.B.........	Canada Iron Corporation, Ltd., Montreal Que................	10	1,631
42	Molybdenite.........	Pontiac Co., Que......	P. H. Chabot and Co., Ottawa, Ont........		1,000
43	Corundum...........	Bancroft, Ont.........	Manufacturers Corundum Co., Ltd., Toronto, Ont..........	3	059

III

DESCRIPTION OF SEVERAL MINING PROPERTIES, AND TESTS MADE

BY

G. C. Mackenzie, B.Sc.; W. B. Timm, B.Sc.; and C. S. Parsons, B.Sc.

The Jamieson Molybdenite Mine.

The Jamieson mine is situated on Lots 5 and 6, Concession VIII, in the township of Lyndoch, county of Renfrew, Province of Ontario. It is 45 miles from the town of Renfrew, 35 miles from Caldwell Station, on the Grand Trunk railway, Ottawa and Parry Sound branch, and 25 miles from Eganville station on the same railway.

The property is owned by the Jamieson Meat Company, of Renfrew, Ont., and is leased to the "Orillia Molybdenum Mines, Ltd." Mining operations commenced about July 1, 1915.

The vein outcrops on top of a ridge of gneiss, and has been exposed for a length of 200 feet along the strike, which is northeast, southwest. The dip of the vein material at the surface is about 45° from the horizontal. Twenty feet below the surface the dip, as exposed by the pit workings, is much flatter—about 30° from the horizontal. The hanging wall rock is crystalline limestone, and along the contact a band of pink calcite occurs. The footwall rock is gneiss.

The vein exposed in No. 1 pit was about 6 feet wide at the surface. In the shaft it decreased to a width of about 2 feet, but when last seen was showing an increasing width. The shaft is about 40 feet on the incline below the surface. It is the intention to drift in both directions on the vein at this point.

The vein material as exposed in No. 2 pit is about 6 feet wide. On the northeast end of the pit a narrow stringer of galena intersects the vein. Whether the vein has been faulted at this point has not been determined. Test pits to the northeast on the strike have failed to show any indications of it.

Between No. 1 and No. 2 pits, the vein has been stripped showing vein material of a width of 3 feet, with very little molybdenite. The northeast drift from the shaft of No. 1 pit will develop this portion.

An estimation of the tonnage that could be expected from this mine is practically impossible. There are, however, approximately 200 tons of 1% ore on the dump in fines and lump.

According to the books of the Orillia Molybdenum Mines, Ltd., there have been shipped to Orillia for concentration 1,720 bags of 3% ore, weighing 85 pounds each, and 243 bags of 18% ore, weighing 100 pounds each, a total of 1,963 bags, containing 170,500 pounds of ore, with a total content of 8,760 pounds of pure molybdenite. Summing up, there have been extracted from the open-cuts, since July 1, 285 tons of ore, with a content of approximately 12,760 pounds of pure molybdenite.

At about 3,600 feet southwest of No. 1 Pit of the Jamieson claim, and on the same strike, the Orillia Molybdenum Mines have staked another claim called the Lybdoch. It is the intention of the Company to work this claim in conjunction with the Jamieson. Surface indications are said to be very promising.

The buildings consist of a sleeping house to accommodate 30 men, a dining camp, an office, a storehouse, and stable. These are situated in the valley to the northeast of the mine. At the mine the only buildings are a blacksmith's shop and a powder house. The broken ore is lifted from the pits by a derrick, dropped on to a sorting floor, graded, and the waste delivered by the tram car on to the waste dump. Drilling, so far, has been done by hand.

Molybdenite Ore from Mr. P. H. Chabot.

A shipment of approximately 1,000 pounds of molybdenite ore was received at the Ore Testing Laboratories from Mr. P. H. Chabot, of Ottawa, Ontario.

The ore was obtained by Mr. Fred Winning of Ottawa, who is associated with Mr. Chabot, from their claim on the south half of lots 21 and 22, range V, Township of Huddersfield, County of Pontiac, Province of Quebec. This property is situated 38 miles by wagon road north-west of Shawville, 28 miles by wagon road north of Campbell's Bay, and 10 to 12 miles by winter road north east of Fort Coulonge. These three places are railway points on the Pontiac branch of the Canadian Pacific railway.

The shipment consisted of what in Mr. Winning's opinion, would represent the grade of ore which would be milled if the property developed to such an extent that it would warrant the erection of a concentrating plant at the mine. Observations show the ore to be clean, containing very little pyrite or pyrrhotite, the molybdenite being disseminated through a pyroxenite gangue. The crystal flakes will average from ⅛ inch to 1 inch in diameter.

The ore outcrops on the top of a hill. An open cut 6 feet at its deepest point, about 6 feet wide and 15 feet long, was observed from which some milling ore and some flake had been obtained. The hanging wall of the vein is crystalline limestone. The footwall rock was not determined as it could not be found to outcrop, there being considerable depth of surface soil. The vein was stripped for only a few feet around the open cut.

The shipment to the ore testing laboratories weighed 1038 pounds. The ore was fed to a jaw crusher set at 1 inch opening, elevated to the ore bins from which it was fed to a set of rolls at ½ inch opening. From the rolls it passed to a Ferraris screen fitted with 1-16 and ⅛ inch screens. Pickers were placed on the side of screen to pick out any coarse flakes of molybdenite which had been freed in the crushing. From this operation the following products were made:—

Hand picked flakes	2·5	pounds
— 1/16 inch size	251·0	"
— ⅛″ 1/16″ size	73·0	"
+ ⅛″ inch oversize	8·0	"

The oversize plus ⅛ inch was fed to the rolls set at ¼ inch opening, from which it was delivered to the screen. The products made were:—

Hand picked flake	1·5	pounds.
— 1/16 inch size	115·0	"
— ⅛ inch, 1/16 inch size	62·0	"
+ ⅛ inch oversize	383·0	"
Dust from dust collector	5·0	"

The oversize plus ⅛ inch was fed to the rolls set at ⅛ inch opening and delivered to the screen. The products made were:—

Hand picked flake	1·0	pounds.
— 1/16 inch size	320·0	"
— ⅛ inch, 1/16 inch size	130·0	"
+ ⅛ inch oversize	41·0	"
Dust from dust collector	5·0	"

The oversize plus ⅛ inch was fed to the rolls set at 1/16 inch opening and delivered to the screen. The products made were:—

Hand picked flake	0·25 pounds.
Mica, wood, etc., discarded	0·75 "
$-\frac{1}{16}$ inch size	31·00 "
$-\frac{1}{8}$ inch $+\frac{1}{16}$ inch size	8·00 "
Dust from dust collector	0·50 "

It was found on examination of the $-\frac{1}{8}+\frac{1}{16}$ inch size that the molybdenite was not entirely freed from the gangue. This size was passed through the rolls set at $\frac{1}{16}$ inch opening and delivered to the screen. The productions made were:—

Hand picked flake	1·0 pound.
$-\frac{1}{16}$ inch size	241·0 pounds.
$+\frac{1}{16}$ inch oversize	27·0 "
Dust from collector	2·0 "

The oversize plus $\frac{1}{16}$ inch was sent to the rolls set at a little closer than $\frac{1}{16}$, and delivered to the screen. The products made were:—

Hand picked flake	2·0 pounds.
Mica, wood, etc., discarded	1·5 "
$-\frac{1}{16}$ inch size	25·0 "
Dust from dust collector	1·0 "

The above operations were conducted in order to crush the ore in stages, remove any large flakes of molybdenite as they were freed from the gangue by hand-picking, to make a minimum amount of fines and to prevent the flake from being ground and broken up so that it would not go into the finer sizes.

The products obtained from the above operation were as follows:—

Hand picked flake	weight	8·25 pounds.
	analysis	85·0% MoS_2 (approx.)
	content	7·01 pounds MoS_2.
Mica, wood, etc., discarded	weight	2·25 pounds.
	analysis	nil.
	content	nil.
Dust from dust collector	weight	18·50 pounds.
	analysis	1·26% MoS_2.
	content	0·23 pounds MoS_2.
$-\frac{1}{16}$ inch size	weight	9·85 pounds.
	calculated analysis	1·26% MoS_2.
	content	0·23 pounds MoS_2.
Handling loss	weight	24·0 pounds.
	analysis	1·25% MoS_2.(approx.)
	content	0·30 pounds MoS_2.

Total weight of products....1038 pounds.
Total content of product....24·09 pounds MoS_2.
Analysis of shipment....2·32% MoS_2.
Size $-\frac{1}{16}$ inch was fed to the Keedy sizer.
From the sizer, the following sizes were made:—

Size	Screen	Weight, lbs.	% MoS_2	Content lbs., MoS_2
+ 20 s.w.	·0410 ins.	355	2·92	10·37
+ 24 s.w.	·0342 "	138	0·851	1·17
+ 28 s.w.	·0282 "	34	1·26	0·43
+ 34 s.w.	·0229 "	52	0·973	0·51
+ 42 s.w.	·0183 "	55	0·924	0·51
+ 50 s.w.	·0145 "	89	1·31	1·17
+ 4 xx	·0116 "	85	0·803	0·68
+ 6 xx	·0089 "	36	0·876	0·32
+ 8 xx	·0068 "	32	0·924	0·30
+ 10 xx	·0054 "	27	1·04	0·28
+ 12 xx	·0041 "	11	1·11	0·12
+ 15 xx	·0036 "	17	1·07	0·18
+ 25 std.	·0026 "	7	1·07	0·17
− 25 std.		13	1·21	0·16
Clean up	of sizes	34	0·827	0·28
Total.........		985	1·68	16·55

The object of sizing so closely was to determine the results obtained by crushing in stages, and whether it would be advisable to eliminate the finer sizes from further treatment.

CONCENTRATION.

Three sizes were made of the sized material from the Keedy sizer, and concentrated on the water flotation machine built at the testing laboratories.

Size + 20 s.w.....................weight 355 pounds.
analysis 2·92% MoS_2.
content 10·37 pounds MoS_2.

From this were obtained:—

1st concentrate.....................weight 26 pounds.
analysis 36·09% MoS_2.
content 9·38 pounds MoS_2.

1st tailing.......................weight 329 pounds.
analysis 0·39% MoS_2.
content 1·28 pounds MoS_2.

Size + 4 xx.......................weight 453 pounds.
analysis 0·99% MoS_2.
content 4·47 pounds MoS_2.

From this were obtained:—

1st concentrate...................weight 12 pounds.
analysis 21·75% MoS_2.
content 2·61 pounds MoS_2.

1st tailing.......................weight 441 pounds.
analysis 0·146% MoS_2.
content 0·64 pounds MoS_2.

Size − 4 xx.......................weight 195·5 pounds.
analysis 0·99% MoS_2.
content 1·94 pounds MoS_2.

From this were obtained:—

1st concentrate	weight	16·5 pounds.
	analysis	6·88% MoS_2.
	content	1·14 pounds MoS_2.
1st tailing	weight	179 pounds.
	analysis	0·268% MoS_2.
	content	0·48 pounds MoS_2.

Note.—To this last size was added the dust from the dust collector.

From the first concentration there were obtained:—

First concentrates	weight	54·5 pounds.
	analysis	24·10% MoS_2.
	content	13·13 pounds MoS_2.
First tailings	weight	949 pounds.
	analysis	0·253% MoS_2.
	content	2·40 pounds MoS_2.

The recovery in 1st concentrates was therefore 84·55% of the molybdenite values in the – 1/16 inch size and the dust.

The 54·5 pounds of 1st concentrate was fed to a Wilfley roaster to give any pyrite and pyrrhotite in the concentrate a coating of oxide. The temperature in the furnace was held under 1050° Farenheit. The quantity of concentrates roasted was so small that a large handling loss was here met with. Only 35·5 pounds of roasted concentrates were obtained.

The roasted concentrates were sized on a 20-mesh screen and returned to the water flotation machine. The second concentrate was re-run over the machine giving a final flotation concentrate of:—

weight	11 pounds.
analysis	85·15% MoS_2.
content	9·37 pounds MoS_2.

Second and third flotation middlings obtained:—

weight	14·0 pounds.
analysis	3·61% MoS_2.
content	0·51 pounds MoS_2.

The loss in samples and roasting this small quantity of concentrates was 19 pounds containing 2·41 pounds of MoS_2.

Table of Final Products Obtained.

Products	Weight pounds	Analysis % MoS_2	Content pounds MoS_2	% MoS_2 of total
Hand picked flake	8·25	35·00	7·01	31·1
Mica, wood, etc., discarded	2·25	nil	nil	0·0
Flotation concentrates	11·00	5·15	9·37	41·0
Flotation middlings	22·50	6·00	1·35	5·9
Flotation tailings	49·00	0·253	2·40	10·5
Loss in sampling and roasting	19·00	12·68	2·41	10·5
Handling loss in crushing	24·00	1·250	0·30	1·3
Totals	1036·00	2·20	22·84	100·3

The flotation middlings in the above table include both the middlings and tailings obtained from the second and third concentration on the flotation machine. These products in actual practice would be returned to the operation as middlings.

The sampling loss, roasting loss and handling loss would not be met with in actual practice and should not be considered in calculating the recovery.

From the above table it will be noted that there were obtained 19,125 pounds of flake and concentrates with an analysis of 85·1% MoS_2, a recovery of 72·1% of the molybdenite values in the ore, and a recovery of 81·3% of the MoS_2 values of the sampling, roasting and handling losses are not considered.

22·5 pounds of middlings were obtained with an analysis of 6·00% MoS_2 representing 5·9% of the molybdenite values in the ore or 6·7% not considering losses.

Conclusions.

The ore contains considerable fine flake. Crushing in stages although making a small percentage of fines, the fines that are obtained gave an analysis similar to that of the coarser sizes. There would be considerable loss in rejecting the fines.

Coarse crushing and hand picking of the larger flake should be resorted to as a large percentage of flake can be obtained in this manner. Waste should also be picked out so as to increase the grade of the products to be concentrated.

After hand-picking the ore can be crushed to 16 or 20 mesh and sized for separation by flotation. The ore is adaptable to the water flotation process. By hand picking of the coarser flake and concentration by water flotation a recovery of 80% to 85% of the molybdenite values should be obtained.

W. B. Timm.

Molybdenite Ore received from J. D. Roche.

The ore was crushed in a small jaw crusher and rolls to pass a 20 mesh screen. This crushed product was then fed to the Woods flotation machine.

Weight of ore fed to machine	150 pounds.
Analysis	0·81% MoS_2.
Content	1·215 pounds of MoS_2.

Concentrate obtained	0 lbs. 12 oz.
Middling obtained	1 lb. 8 oz.
Tailing obtained	124 lbs. 0 oz.
Loss in slimes	23 lbs. 12 oz.

The concentrate was re-treated.

Final concentrate	0 lbs. 3·75 oz.
Tailing	0 lbs. 3·50 oz.
Loss in handling	0 lbs. 4·75 oz.

The middling from the first treatment and the tailing from the retreatment of the concentrate were mixed together and called a final middling product. In practice these two products would either be dried and returned with the feed or retreated on separate machines.

The following table shows the final results of the test.

Products	Weights	MoS_2 %	Contents of MoS_2 in lbs.	P.C. MoS_2 of Total.
Crude	150 lbs. – 00·00 oz.	0·81	1·215	100·00
Final concentrates	0 „ – 3·75 „	91·93	·216	17·77
Final middling	1 „ – 11·50 „	6·21	·107	8·81
Final tailing	124 „ – 00·00 „	·25	·310	25·51
Toluts of Product	126 „ – 15·75 „		·669	55·05
Losses	23 „ – 0·75 „		·546	44·95

It can be seen from the above that a high grade concentrate was obtained which ran 91·93% MoS_2 but that only 17·77% of the MoS_2 in the ore was recovered in it.

It will also be noted that 44·95% of the molybdenite values in the ore were lost in the process of concentration. This was due to handling such a small quantity of ore over the large flotation machine.

The figures in the above table have not quantitive value. They do however tend to show that the ore is adaptable to the water flotation process. The ore contained very little iron sulphide, which simplifies the process considerably. This fact alone is encouraging as it is difficult to separate the molybdenite from the iron sulphides.

C. S. Parsons.

The Chisholm Molybdenite Mine.

The Chisholm mine is situated on lot 5, concession XIV, of the township of Sheffield, county of Addington, province of Ontario. It is 36 miles north of Kingston, 6 miles from the village of Enterprise, on the Bay of Quinte branch of the Canadian Northern railway, and about 2½ miles from the Canadian Pacific railway's short line from Ottawa to Toronto.

This property is owned by A. M. Chisholm, of Kingston, Ontario, and J. A. Seybold, of Ottawa, Ontario.

The outcrop is exposed for 100 feet along the strike, which is northeast and southwest. Two pits have been sunk on the ore body, pit No. 1 to a depth of 18 feet below the surface, and pit No. 2 to a depth of 8 feet below the surface. Between the two pits is a dike of limestone, 20 feet wide striking with the ore.

The ore body exposed by the two pits appears to have been covered by an overthrust capping of limestone.

Gneissoid granite outcrops several hundred feet east of the property, but no contact between the gneiss and limestone was observed. It was difficult to establish with certainty the dip of the ore body owing to its broken condition near the surface, but indications point to a dip towards the northwest.

In No. 1 pit, the ore body is more or less broken up by horses of crystalline limestone. The southwest side of the pit, however, is almost solid sulphides over a width of 30 feet. On the northeast side of the pit and on the hanging wall side, the sulphides and pyroxenite occur in pockets through the limestone. In pit No. 2, the entire bottom of the pit is clean sulphides and pyroxenite vein material.

The molybdenite occurs associated with pyrrhotite, pyrite, and pyroxenite. Mica occurs as a gangue mineral, being more noticeable near the surface. The ore from No. 2 pit contains little mica. The crystal flakes of molybdenite average ¼″ to 1″ in diameter, although much larger flakes are obtained. The

ore from this mine is much heavier than that from the Renfrew county mines, as it contains a much larger percentage of the heavy sulphides. The ore body has been stripped for only a few feet beyond the pits. The extent along this strike or the width of the ore formation has not been proven. Stripping is necessary to uncover the ore body in its lateral extent.

Mining operations have been carried on since June 1, 1915, on a small scale. Ten to twelve men have been employed since that date. Previous to the above date some ore was extracted from No. 1 pit and shipped to the States, and considerable milling ore was accumulated on the surface.

The ore broken since June 1, from the open cuts and stocked, is estimated at 500 tons averaging about 1 per cent MoS_2. The milling ore on the surface extracted from the pit before that date is about 500 tons, making a total of 1,000 tons averaging about 1 per cent MoS_2,—a content of 10 tons of pure MoS_2.

The equipment consists of:—

One 12 H.P. vertical boiler.
One single drum hoisting engine.
One 3¼″ steam rock drill.
Two 2-ton derricks.

The ore is hoisted from the pits and placed on the stock piles. The waste hoisted is loaded into wagons and delivered to the waste dump.

The mine buildings consist of:—

One small boiler and engine room.
One blacksmith shop.
One dining house.
One bunk house.
One storehouse.
One stable.

No ore is actually blocked out. The ore in sight is that which can be seen in the faces exposed by the open cuts, and this is over a considerable surface area. The lateral extent and width of the ore body has not been proven. The work done has been confined to the two open cuts above mentioned.

The deposit promises to be one of considerable value, and if the owners had paid more attention to stripping the surface soil and limestone capping, instead of sinking pits on the ore, they would have in all probability shown us a large sized body of ore. Acting on our advice, the owners are now proceeding to strip the ore body in both directions.

W. B. Timm.

Mount St. Patrick Molybdenite Ore.

In May, 1915, a carload of molybdenite ore was received from the Mount St. Patrick district for testing purposes at the Ore Testing Laboratories of the Mines Branch.

This carload contained 10 tons of ore from the Ross claim known as the Moran property, situated on lot 16, concession XI, township of Brougham, Renfrew county, Ontario, and 16 tons from the Hunt property on lot 8, concession XI, township of Brougham, Renfrew county, Ontario.

The first named property is owned by C. G. Ross of Ottawa, Ontario, and associates; the latter by the Renfrew Molybdenum Mines, a subsidiary company of the Algunicon Development Co. of which A. E. Goyette Esq., Grand Mere, Que., is vice-president.

The Ross Molybdenite Ore.

Several small tests were made on this ore using the minerals separation four-cell unit as the method of concentration. Different grades of oil and mixtures were used.

The ore was crushed to pass a 40 mesh screen, and the green ore fed to the unit using eucalyptus and coal oil with a small amount of acid. The concentrate obtained carried considerable of the iron sulphides and had to be re-treated to bring it up to grade. The tailings from the tests on the crude ore gave an analysis of 0·2% MoS_2.

A second series of experiments were tried by roasting the crushed ore at a temperature of 1000° F., and then sending the roasted ore to the flotation unit. A much better grade of concentrates was obtained but it was found that the roast was very difficult to control, i.e., to obtain the required roast without volatilizing and changing some of the molybdenite particles.

From the above shipment 100 pounds of molybdenite concentrates were obtained with an analysis of 85% MoS_2.

Molybdenite Ore from Renfrew Molybdenum Mines.

The net weight of this shipment was 31,479 pounds or 15·74 tons.

The ore was crushed in a jaw crusher set at $\frac{3}{4}''$ opening and passed through a set of rolls onto a Ferraris screen fitted with $\frac{1}{16}''$ screens. The oversize + $\frac{1}{16}$ was returned to the rolls until the whole shipment with the exception of 13·5 pounds of flake passed through the screen.

The material through the $\frac{1}{16}''$ screen was sent to a water flotation machine. The first concentrate and first middlings obtained were sized and re-treated. The results obtained from the shipment were as follows:—

Screened Flake	13·5 pounds
Analysis	89·5 % MoS_2
Content	12·08 lbs. MoS_2
Concentrates	196·5 pounds
Analysis	82·565% MoS_2
Content	162·24 lbs. MoS_2
High Grade Middlings	15·25 pounds
Analysis	41·44% MoS_2
Content	6·32 lbs. MoS_2
Low Grade Middlings	3017·0 pounds
Analysis	1·72% MoS_2
Content	52·00 lbs. MoS_2
Tailings	28262·0 pounds
Analysis	0·11% MoS_2
Content	32·37 lbs. MoS_2
Total content of shipment	265·01 lbs. MoS_2
A calculated head analysis of	0·84% MoS_2

Preliminary Report on Corundum Ore from Bancroft, Ontario.

A shipment of 6,059 pounds was received on Dec. 21, 1915.

The ore was fed to a jaw crusher set at 1″ opening and then to rolls at $\frac{1}{2}''$. The product from the rolls then passed over a Ferraris screen equipped with $\frac{1}{4}''$ opening and $\frac{1}{2}''$ opening screens. The weights of the sizes were as follows:—

Made —$\frac{1}{4}$ inch screen	3,081
Made —$\frac{1}{2}$ + $\frac{1}{4}$ inch screen	1,214
Made + $\frac{1}{2}$ inch screen	1,678
Made dust from dust collector	86
	6,059

The oversize from the $\frac{1}{4}$ and $\frac{1}{2}$ inch screens were combined and returned to the rolls set at $\frac{1}{8}$ inch opening.

Made — $\frac{1}{4}$ inch screen	2,785
Made dust from collector	105
	2,890

The screens on the Ferraris screen were changed to a 1–16 inch opening and a $\frac{1}{8}$ inch opening.

The product from the — $\frac{1}{4}$ inch screen was returned to the rolls set at 1–16 inch opening.

Made — $\frac{1}{16}$ inch screen	4,259
Made — $\frac{1}{8}$ + $\frac{1}{16}$ inch screen	814
Made + $\frac{1}{8}$ inch screen	132
Made dust	5,432

The oversize on the $\frac{1}{8}$ and $\frac{1}{4}$ inch screens was returned to rolls set at 1–16 inch opening.

Made — $\frac{1}{16}$ inch screen	735
Made — $\frac{1}{8}$ + $\frac{1}{16}$ inch screen	208
Made + $\frac{1}{8}$ inch screen	32
Made dust from collector	70
	1,045

The oversize of the $\frac{1}{8}$ and $\frac{1}{16}$ inch screens was again returned to the rolls set as before.

Made — $\frac{1}{16}$ inch screen	190
Made — $\frac{1}{8}$ + $\frac{1}{16}$ inch screen	63
Made + $\frac{1}{8}$ inch screen	9
Made dust from collector	15
	277

The oversize was returned to the rolls and all crushed to pass 1–16 inch screen.

Made — $\frac{1}{16}$ inch screen	210
Made dust from collector	5
	215

Made total material through $\frac{1}{16}$ inch screen	5,560 pounds
Made total dust from collector	413 "
	5,982

The material through the $\frac{1}{16}$ inch screen and the dust from the dust collector was fed to a Keedy sizer and the sizes made and their weights are as follows:—

Mesh	*Aperture*	*Weight*
+ 6		13
+ 8		97
+ 12		667
+ 16		989
+ 20		352
+ 24		460
+ 28		422
+ 34		449
+ 42		418
+ 50		293
+ 62		333
+ 74		239
+ 86		108
— 86		1,133
		5,973

Weight of ore fed to crusher.......................... 6,059 pounds
Weight of ore from combined sizes from sizer.............. 5,973 "

Loss in handling dust, etc........................ 86 "

Test No. 1.

Preliminary Concentration Test.

On examining sizes 6 mesh and 8 mesh it was found that the mineral had not been freed so it was decided not to attempt to concentrate them. An attempt was made however to treat sizes 12 to 28 inclusive on a James Jig but the results were not encouraging. Sizes 34 to 74 were treated on an Overstrom table with good results.

The following table shows the work done in the preliminary test No. 1.

Treatment on James Jig.

Size	Concentrate from 1st Jig	Concentrate from 2nd Jig	Hutch	Tailing	Remarks
+ 12	95·5	32	8·5	498·5	Note: The jigs were run in series the 2nd cleaning the tails from the 1st.
+ 16	106·5	42	17·0	798·0	
+ 20	16·0	39	13·0	279·0	
+ 24	44	9	15·5	377·0	
+ 28	37	18	18·5	281·0	

Treatment on Overstrom Table.

Size	Concentrate		Middling		Tailing	Weight Feed
	Weight lbs.	Per cent of feed	Weight lbs.	Per cent of feed	Weight lbs.	lbs.
+ 34	20	4·45	35·25	7·25	376	449
+ 42	12·50	2·99	36·00	8·62	355·5	418
+ 50	7·25	2·47	13·50	4·61	275·0	293
+ 62	9·25	2·79	5·25	1·58	292·0	332
+ 74	6·50	2·72	7·50	3·14	213·0	239
Total....	55·50	3·21	97·50	5·63	1,511·5	1,731

Loss in handling..........66·50 pounds.

Magnetic Separation of Table Concentrates.

The concentrates obtained from the table were fed to an Ullrich magnetic separator.

Size	Feed	Concentrates			Tailing		
		Weight	Per Cent of feed	Per Cent of feed to table	Weight	Per Cent of feed	Per Cent of feed to table
34	20	12·44	62·20	2·77	7·81	39·01	1·740
42	12·5	7·75	62·00	1·85	2·75	22·00	·658
50	7·25	5·88	81·10	2·01	1·25	17·25	·427
62	9·25	7·37	79·70	2·22	0·5	5·40	·150
74	6·50	5·75	88·50	2·41	1·25	19·24	·520
Total.....	55·50	39·187	70·60	2·26	13·56	24·45	·783

The difference in weight is due to loss of tailing only.

The concentrates from the first pass through Ullrich were again returned to the separator. The poles of the machine were brought as close together as possible and the maximum average of 10 was used.

Size	Feed	Concentrates			Tailing			Remarks
		Weight	Per Cent of feed	Per Cent of feed to table	Weight	Per Cent of feed	Per Cent of feed to table	
+ 34	12·44	11·81	95·0	2·63	0·44	3·54	·098	Note: Difference in weight is due to loss of tailing product only.
+ 42	7·75	6·56	84·6	1·57	0·725	8·06	·150	
+ 50	5·88	5·375	91·20	1·83	0·375	6·38	·128	
+ 62	7·37	7·00	95·00	2·11	0·31	4·20	·093	
+ 74	5·75	5·00	87·00	2·09	0·18	3·13	·075	
Total.....	39·187	35·75	91·20	2·06	1·94	4·95	1·12	

Note: The above concentrates are lower in grade than those obtained from the same sizes in test No. 2. This was due to being unfamiliar with the character of the ore.

Summary of Treatment of Table Concentrate Test No. 1.

Total weight of concentrate from magnetic separator............	35 lbs., 12 oz.
Total weight of tailing from 1st pass through separator............	13 lbs., 09 oz.
Total weight of tailing from 2nd pass through separator............	1 lbs., 15 oz.
Total loss in weight due to sampling and handling..............	4 lbs. 4 oz.
Total weight of concentrate from tables......................	55 lbs., 8 ozs.

The total concentrate obtained from the magnetic separator represents 2·06% of the ore feed to the tables.

Test No. 2.

Final Concentration Test.

The products and sizes from test No. 1 with the exception of sizes + 34 to + 74 were mixed together and all crushed to pass the 24 mesh screen of the Keedy sizer. The oversize was returned to the rolls which were set up tight until all had passed through the 24 mesh screen. Sizes + 34 to + 74 inclusive were not mixed back because good results had been obtained from them on the table.

The Keedy Sizer.

Sizes and Weights.

Size	*Aperture (inches)*	*Weight*
+ 28	·0282	748
+ 34	·0229	324
+ 42	·0183	275
+ 50	·0145	352
+ 62	·0116	390
+ 74	·0089	274
+ 86	·0068	278
+109	·0054	324
+125	·0041	173
+150	·0036	202
+200	·0026	110
—200		472
Total..		3,923

Each of the following sizes were run over the Overstrom table:—

Size	Aperture inches	Feed	Concentrates		Middling		Tailing		Remarks
			Weight	Percent of feed	Weight	Percent of feed	Weight	Percent of feed	
+ 28	·0282	749	33·00	4·41	81·50	10·9	631	84·40	*Note.*—The difference in weight is due to loss of the tailing *only.* Loss 249·5 lbs.
+ 34	·0229	324	13·0	4·01	23·00	7·1	276	85·20	
+ 42	·0183	275	11·75	4·27	25·00	9·09	238	86·60	
+ 50	·0145	352	13·00	3·70	18·00	5·12	296	84·10	
+ 62	·0116	390	15·75	4·03	9·50	2·44	342	87·70	
+ 74	·0089	274	10·75	3·92	8·25	3·01	248	90·50	
+ 86	·0068	278	12·00	4·32	3·25	1·17	261	93·90	
+ 109	·0054	324	13·75	4·25	19·25	5·94	279	86·10	
+ 125	·0041	173	7·75	4·48	10·25	5·92	127	73·40	
+ 150	·0036	202	8·75	4·33	9·50	4·70	169	83·70	
+ 200	·0026	110	3·75	3·41	4·25	3·86	75	68·20	
*+ 200 (O)		472	4·50	2·07	7·25	2·70	203	75·00	
− 200 (D)			5·25		5·50		151		
Totals......		3,923	153·00	3·90	224·50	5·72	3,296	84·00	

*(O) Overstrom. Overstrom table work on 2nd test.
(D) Deister slimer.

Size	Aperture	Feed	Concentrates			Tailings			Remarks
			Weight	% of feed	% of feed to table	Weight	% of feed	% of feed to table	
+ 28	·0282	33·00	26·88	81·43	3·59	5·25	15·92	·702	*Note.*—The difference in weight between the sum of the product and the feed is due to loss of tailing *only*.
+ 34	·0229	13·00	11·06	85·10	3·41	0·25	1·92	·077	
+ 42	·0183	11·75	10·44	88·8	3·80	0·88	7·49	·320	
+ 50	·0145	13·00	11·25	86·6	3·20	1·12	8·62	·318	
+ 62	·0116	15·75	13·12	83·8	3·36	1·25	7·92	·321	
+ 74	·0089	10·75	9·31	86·6	3·40	0·62	5·77	·226	
+ 86	·0068	12·00	10·81	90·1	3·89	1·06	8·83	·381	
+ 109	·0054	13·75	12·56	91·4	3·88	·62	4·51	·191	
+ 125	·0041	7·75	6·88	88·80	3·98	·37	4·77	·214	
+ 150	·0036	8·75	8·19	93·60	4·05	1·00	11·42	·495	
+ 200	·0026	3·75	3·50	93·30	3·18	·31	8·27	·282	
− 200 (O)		4·50	2·94	71·20	1·46	1·12	12·12	·458	
− 200 (D)		5·25	4·00			1·06			
Totals......		153·00	129·88	84·90	3·31	14·94	9·77	·381	

(O) Indicates that the product is from Overstrom.
(D) Indicates that the product is from Deister slimer.

Size	Aperture	Feed	Concentrates			Tailing			Remarks
			Weight	% of feed	% of feed to table	Weight	% of feed	% of feed to table	
+ 28	·0282	26·88	24·62	91·60	3·29	2·25	8·37	·301	*Note.*—Difference in weight between the sum of the products and the feed is due to loss of tailing *only*.
+ 34	·0229	11·06	10·50	94·95	3·24	0·56	5·06	·173	
+ 42	·0183	10·44	10·00	95·80	3·64	0·44	4·20	·160	
+ 50	·0145	11·25	11·00	97·80	3·12	0·25	2·20	·071	
+ 62	·0116	13·12	12·94	98·65	3·32	0·19	1·44	·049	
+ 74	·0089	9·31	9·12	97·90	3·33	0·19	2·04	·069	
+ 86	·0068	10·81	10·62	98·30	3·82	0·19	1·75	·068	
+ 109	·0054	12·56	12·37	98·40	3·82	0·19	1·51	·059	
+ 125	·0041	6·88	6·75	98·10	3·90	0·12	1·74	·069	
+ 150	·0036	8·19	7·88	96·20	3·90	0·12	1·46	·059	
+ 200	·0026	3·50	3·25	92·90	2·95	0·06	1·71	·055	
− 200 (O)		2·94	2·56	87·10	1·28	0·06	2·04	·038	
− 200 (D)		4·00	3·50	87·50		0·12	3·00		
Totals......		129·88	125·12	96·35	3·19	4·75	3·65	·121	

(O) Indicates product originally came from Overstrom table.
(D) Indicates product originally came from Deister slime table.

The — 200 mesh product was divided into two portions, one part was fed to the Deister slimer marked (D) above — and the other part to the Overstrom table — marked (O) above.

As far as could be judged the Overstrom did the best work.

Magnetic Separation of Table Concentrates.

The table concentrates were then fed to an Ullrich magnetic separator each size being run separately.

The maximum amperage of 10 amperes was used and the feed pan was set approximately $\frac{1}{8}$ inch from the take off pole.

(See table page 96.)

The concentrates from the first pass through the Ullrich magnetic separator were again returned to the separator. The poles of the machine were brought together as close as possible and the maximum amperage of 10 was used.

(See table page 97.)

Summary of the Treatment of Table Concentrates Test No. 2.

Total weight of concentrate from magnetic separator............	125 lbs. 02 oz.
Total weight of tailing from 1st pass through magnetic separator	14 lbs. 15 oz.
Total weight of tailing from 2nd pass through magnetic separator	4 lbs. 12 oz.
Loss in Sampling table concentrates and in handling products from the separator, etc..................................	8 lbs., 13 oz
Total weight of concentrate from tables........................	158 lbs. 00 oz.

The total concentrate obtained from the magnetic separator represents $3 \cdot 19\%$ of the ore feed to the tables.

Final Summary.

Weight of ore fed to table in Test No. 1......................	1731·00 pounds
Weight of ore fed to table in Test No. 2......................	3923·00 "
Total weight of ore from which concentrates were obtained.....	5654·00 "
Total loss of weight due to dust, handling, etc.................	405·00 "
Total weight of ore fed to jaw crusher........................	6059·00 "
Concentrate recovered from Test No. 1........................	35 lbs. 12 oz.
Concentrate recovered from Test No. 2........................	125 lbs. 02 oz.
	160 lbs. 14 oz.

Total per cent of the ore recovered as concentrates, $2 \cdot 79$ per cent.

In order to free the corundum it was necessary to crush to at least 28 mesh and even then the corundum was not perfectly freed from the hornblende.

With such close sizing the Overstrom table did exceptionally good work especially on size 62 to 125 mesh. Even in the —200 mesh product the Overstrom appeared to do better work than the slimer. The amount of middling made on the table could without doubt have been decreased without noticeably increasing loss in the tailing. No attempt was made to further treat the middlings; in practice they would either be returned with the feed to the table or treated separately.

The first pass of the table concentrate through the magnetic separator resulted in a clean tailing consisting of hornblende and pyrrhotite. The con-

centrate (non-magnetic) still contained a little hornblende and approximately 2·25% of iron pyrites. This concentrate was returned to the separator after its poles had been moved nearer together. A tailing was obtained which consisted of mica and the particles of corundum containing iron or attached hornblende. A very clean looking concentrate was obtained from this last pass.

There is quite a strong indication that the corundum has undergone slight decomposition. A small sample of the final concentrate from the magnetic separator was placed under a microscope and any doubtful looking particles were picked out. The remaining apparently pure corundum particles were placed in a test tube and heated with hydrochloric acid until boiling. The solution was decanted off and diluted and made ammoniacal. A precipitate of aluminium immediately showed. If mica had been present it would hardly have had time to be attacked by the acid as it is practically insoluble in hydrochloric acid.

W. B. Timm

Preliminary Report Bathurst Iron Ore.

Concentration Tests.

Character of Ore.

The ore is a compact mixture of magnetite, hematite, and quartz. The quartz is so finely disseminated that it is hardly apparent to the naked eye.

Test No. 1.

Magnetic Cobber.

About 2 tons of ore were crushed to pass a $\frac{3}{4}$ inch circular punched screen. The ore was then passed over $\frac{1}{2}''$, $\frac{1}{4}''$ and $\frac{1}{8}''$ screens. The weights of the sizes were as follows:—

Made through $\frac{1}{4}''$ screen + $\frac{1}{2}''$ screen	1650 pounds
Made through $\frac{1}{2}''$ screen + $\frac{1}{4}''$ screen	634·5 pounds
Made through $\frac{1}{2}''$ screen + $\frac{1}{8}''$ screen	713 pounds
Made through $\frac{1}{8}''$ screen	804 pounds
Total	3801·5 pounds

TABLE No. 1.

Size	Weight	Per cent of crude ore
$-\frac{3}{4}+\frac{1}{2}$	1650·0	43·42
$-\frac{1}{2}+\frac{1}{4}$	634·5	16·69
$-\frac{1}{4}+\frac{1}{8}$	713·0	18·75
$-\frac{1}{8}$	804·0	21·14
Crude	3801·5	100·00

Each of the above four sizes was a magnetic cobber of the belt and drum type.

Treatment of size — $\frac{3}{4}''$ + $\frac{1}{2}''$

Weight of ore fed to cobber........................1650·0 pounds
Analysis.. 45·30% Fe.
The belt travelled 367 feet per minute.
Rectifying magnets, 6 amperes at 110 volts.
Drum magnets, 30 amperes at 110 volts.

Products	Weight	Analysis % Fe.
Obtained concentrate	935	46·98
" middling	529	45·25
" tailing	186	37·19
" total	1,650	45·30

Treatment of size — $\frac{1}{2}$ + $\frac{1}{4}$

Weight of ore fed to cobber........................634·5 pounds.
Analysis.. 45·15% Fe.
The belt travelled at 367 feet per minute.
Rectifying magnets, 6 amperes at 110 volts.
Drum magnet, 30 amperes at 110 volts.

Products	Weight	Analysis % Fe.
Concentrate	335	47·33
Middling	225	44·93
Tailing	74·5	36·06
Totals	634·5	45·15

Treatment of Size — $\frac{1}{4}$ + $\frac{1}{8}$

Weight of ore fed to cobber........................713 pounds.
Analysis..44·80% Fe.
Speed of belt was 367 feet per minute.
Rectifying magnets, 6 amperes at 110 volts.
Drum magnets, 20 amperes at 110 volts.

Products	Weight	Analysis % Fe.
Concentrate	393	47·60
Tailing	320	41·28
Total	713	44·80

Treatment Size — $\frac{1}{8}$

Weight of ore fed to cobber.......................804·0 pounds.
Analysis.. 45·48% Fe.
Speed of belt, 365 feet per minute.
Rectifying magnets, 6 amperes at 110 volts.
Drum magnets 15 amperes at 110 volts.

Products	Weight	Analysis % Fe.
Concentrate	190·5	50·94
Middling	299·0	48·33
Tailing	314·5	39·47
Totals in feed	804·0	45·48

Summary of Test.

Crude ore contained..............................45·25% Fe.
Concentrates contained...........................47·60% Fe.
Middling contained...............................46·01% Fe.
Tailing contained................................39·37% Fe.

The number of tons of crude ore required to produce one ton of concentrate are approximately 2·5 tons.

This test shows conclusively that the ore cannot be concentrated by coarse magnetic cobbing.

(See table page 102.)

Preliminary Jig Test.

Weight of ore taken..............................3631·00 pounds.
Analysis.. 45·5% Fe.

The ore was crushed in a Blake crusher and rolls until the whole had passed a $\frac{3}{4}''$ circular punched screen.

The following sizes were made:—

Through $\frac{3}{4}''$, on $\frac{1}{2}''$ screen	1,576	pounds
" $\frac{1}{2}''$, on $\frac{1}{4}''$ "	594	"
" $\frac{1}{4}''$, on $\frac{1}{8}''$ "	692	"
" $\frac{1}{8}''$ "	769	"
	3,631	"

Each of the above sizes was tested on a set of James jigs; the jigs were mounted in series, the second jig treating the tailing from the first jig.

A concentrate and a hutch product were obtained from each jig, and tailing was obtained from the second jig. The two hutch products were combined.

The jigs were operated with the object of producing a concentrate averaging about 50 per cent metallic iron.

By combining the concentrates and hutch products from the jig, a product is obtained that will average 49·85 per cent metallic iron.

This represents a recovery of 59·45 per cent of the iron in the ore. That is 40·55 per cent of the iron was lost in the tailing.

TABLE No. 1.

Table of Products from Magnetic Cobber.

Size	Feed			Concentrates								Tailing			
	Weight	p.c. of Fe	Pound of Fe	Weight	p.c. of Fe	Pounds of Fe	p.c. of Fe recovered	Weight	p.c. of Fe	Pounds of Fe	p.c. of Fe recovered	Weight	p.c. of Fe	Pound of Fe	p.c. of Fe lost
− ¾ + ½	1650·0	43·42	747·80	935·0	46·98	439·26	58·77	529·0	45·25	239·37	32·00	186	37·19	69·17	9·23
− ½ + ¼	634·5	45·15	286·52	335·0	44·93	158·55	55·37	225·0	44·93	101·09	35·30	74·5	36·06	26·88	9·36
− ¼ + ⅛	713·0	44·85	319·15	393·0	47·60	187·06	58·60	....	......	....	......	320	41·28	132·09	41·40
− ⅛	804·0	45·48	365·67	190·5	50·94	97·04	26·55	299·0	48·33	144·50	39·5	314·50	39·47	124·13	33·95
Totals........	3801·5	45·25	1719·14	1853·5	47·60	881·91	51·30	1053·0	46·01	484·96	28·20	895·0	39·37	352·27	20·5

Size	Feed					Concentrate from Jig No. 1				Concentrate from Jig No. 2				Hutch from Jig Nos. 1 and 2				Tailing			
	Weight lbs.	per cent of total weight	% Fe	Pounds of Fe	% of total Fe	Weight lbs.	% Fe	Pounds of Fe	% of Fe recovered	Weight lbs.	% Fe	Pounds Fe	% of Fe recovered	Weight lbs.	% of Fe	Pounds Fe	% of Fe recovered	Weight lbs.	% Fe	Pounds of Fe	% of Fe recovered
[illegible]	1,576	43·40	45·6	719·02	43·50	431	51·41	221·43	30·8	281·0	47·28	132·86	18·47	7	46·20	3·34	0·47	857	42·17	361·40	50·30
− ¾ + ½	594	16·35	44·4	266·20	16·11	265	50·10	132·76	49·85	67·0	46·00	30·82	11·56	7	44·55	3·12	1·17	255	39·35	100·34	37·70
[illegible]	692	19·05	45·15	312·39	18·90	253	50·59	128·01	41·00	113·0	47·58	53·76	17·20	9	45·32	4·08	1·30	317	39·92	126·54	40·50
− [illegible]	769	21·20	46·2	355·08	21·49	218·7	51·39	112·41	31·67	92·6	46·73	43·27	12·20	227·8	51·29	116·84	32·90	229	35·91	82·56	23·25
[illegible]	3,631	100·00	45·5	1652·71	100·00	1167·7	50·92	594·61	36·00	553·6	48·30	260·71	15·77	250·8	50·80	127·38	7·70	1,658	40·45	670·84	40·55

Explanation of table.

Take the size, − ¾ + ½. This means through ¾ inch screen and caught on ½ inch screen.
The 1st column under "Feed" is the weight of the ore fed to the jig.
The 2nd column under "Feed" is the per cent the feed is of the total weight, and is found by dividing 3631 into 1576, and multiply by 100, so:

$$\frac{1576 \times 100}{3631} = 43\cdot 40\%$$

The 3rd column is the per cent of iron that feed contains.
The 4th column is the amount of iron in pounds that the feed contains, and is found by: 1576 × 45·6 = 719·02 pounds.
The 5th column is the per cent of the total iron in the ore that the size contains and is found by dividing the number of pounds of iron in this size by the total number of pounds of iron in the ore and multiply by 100, so:

$$\frac{719\cdot 02 \times 100}{1652\cdot 71} = 43\cdot 5\%.$$

1st column under Concentrate from Jig No. 1 is the weight of the concentrate obtained from that size.
2nd column is the per cent of iron the concentrate contains.
3rd column is the number of pounds of iron in the concentrate and is found by multiplying the weight of concentrate by its iron content, so: 431 × 51·41 = 221·43.
4th column is the per cent of the iron contained in the feed that is recovered in the concentrate, and is found by dividing the pounds of iron in the feed into the pounds of iron in the concentrate and multiplying by 100, so:

$$\frac{221\cdot 43 \times 100}{719\cdot 02} = 30\cdot 8$$

The total weight of the combined products would be 1972·10 pounds, and that is 54·30 per cent of the ore fed to the jigs, i.e., it would require 1·84 tons of crude ore to make 1 ton of concentrate containing 49·85 per cent Fe.

Original crude ore contained 45·5 per cent iron.

Concentrate obtained contained 49·45 per cent iron.

Tailing obtained contained 40·45 per cent iron.

The above results are tabulated in the following tables Nos. 3 and 4.

TABLE No. 3.

Products Combined as Concentrate.

	Weight	Analysis % Fe.	Pounds of Fe.
Total concentrate Jig No. 1	1,167·7	50·92	594·61
" " " 2	553·6	48·30	260·71
Total Hutch Jigs, Nos. 1 and 2	250·8	50·80	127·38
Total concentrates obtained	1,972·1	49·85	982·70

TABLE No. 4.

Final Results of Jig Test.

Product	Weight in pounds	% by weight of crude
Total concentrates	1972·1	54·30
Total tailing	1658	45·68
Loss of weight	0·9	·02
Original crude ore	3631·0	100·00

(See table page 104.)

Conclusions.

This test was not completed. The tailings from sizes — $\frac{3}{4}$ + $\frac{1}{2}$, — $\frac{1}{2}$ + $\frac{1}{4}$ and — $\frac{1}{4}$ + $\frac{1}{8}$, should be recrushed in rolls until the whole passed through the $\frac{1}{8}$ inch screen; this would result in much higher recovery, probably about 70 per cent of the iron content of the crude would be recovered in the concentrate. These tailings could be retreated until an economical limit was reached.

If a higher grade concentrate than 50 per cent is desired, it would be necessary to retreat that much more tailing. It is very doubtful, due to the character of the ore, if a concentrate containing more than 50 per cent iron could be obtained without fine grinding.

Test 3.

A series of tests were made to ascertain if the ore could be crushed to a point at which the quartz and other gangue materials would be set free, but the iron in the form of hematite would still remain associated with the magnetite.

These tests all gave negative results, as the following records show. They also proved that it was necessary to fine-grind the ore in order to obtain a high grade concentrate.

TABLE No. 5.

Final Results of Jig Test.

Feed			Concentrate				Tailing			
Weight	Analysis % Fe	Pounds of Fe	Weight in pounds	Analysis % Fe	Pounds of Fe	p.c. Fe in feed contained in concentrate	Weight	Analysis % Fe	Pounds of Fe	p.c. Fe in feed contained in tailing
3631	45·5	1652·71	1972·1	49·85	982·70	59·45	1658	40·45	670·84	40·55

Test 3a.

25 pounds of ore were crushed to pass an 8 mesh screen and then fed to small magnetic separators working on a dry feed.

A concentrate was made containing 50·67% metallic iron and a tailing containing 35·24% metallic iron.

Test 3b.

25 pounds of ore were crushed to pass a 16 mesh screen, and then fed to the magnetic separator.

Concentrate	50·77%	metallic iron
Tailing	33·77%	" "

Test 3c.

25 pounds of ore were crushed to pass a 24 mesh screen and then fed to the separator.

Concentrate	50·59%	metallic iron
Tailing	31·05%	" "

Test 3d.

25 pounds of ore were crushed to pass a 24 mesh screen and fed to a wet magnetic separator.

Concentrate	50·09%	metallic iron
Tailing	26·09%	" "

Conclusion.

The ore as stated above is a mixture of magnetite, hematite and quartz. The quartz is in very fine grains, which are hardly apparent to the eye, and it is necessary to fine grind the ore in order to free these grains. But when the ore is subjected to fine grinding, the hematite is also set free, and is lost in the tailing when the ore is treated by magnetic separation. A fourth test is therefore proposed in which the ore is ground in a Hardinge conical ball mill and then passed through a Grondall magnetic separator, the tailings from which will then be concentrated on tables in the hope of saving any iron which is in the form of hematite.

C. S. Parsons.

Report on Milling Molybdenite Ore from the Chisholm Mine, County of Addington, Ontario.

A carload shipment of molybdenite ore was received at the testing laboratories from the Chisholm mine, situate on lot 5, concession XIV, of the township of Sheffield, county of Addington, Province of Ontario. The property is owned by A. M. Chisholm, of Kingston, Ontario, and J. A. Seybold, of Ottawa, Ontario.

The carload was made up of three lots,—lot No. 1 being sorted ore; lot No. 2 run of mine, and lot No. 3 representing the ore from the bottom of the open cut at time of shipment. These lots were mixed in some manner so that the concentration tests made do not represent what these separate lots contained. Lot No. 2, however, is a fairly representative one of the grade of milling ore to be expected.

1 A. The mineral constituents of the ore are pyrite, pyrrhotite, molybdenite, mica, pyroxenite, hornblende, and calcite. It is a very heavily sulphide ore, the molybdenite being associated with the other sulphides. The crystal flakes are up to an inch in diameter, thus allowing a certain amount of hand picking of the larger flake before concentration.

Run No. 1.

7,200 pounds of lot No. 1 were taken and fed to a jaw crusher set at 1 inch opening. From the crusher the ore went to rolls at ½″ opening, and from the rolls into a Ferraris screen fitted with ⅛″ and 1/16″ screens. Two men were placed on each side of the screen to pick any flake that was freed from the gangue. The oversize, ⅛″, was sent to the rolls set at ¼″ opening, then at ⅛″ and 1/16″ until the entire lot passed the ⅛″ screen.

Size —⅛″ 1/16″ was then sent to the rolls and this size reduced to pass a 1/16″ screen.

From the above operations the following products were obtained:—

Product	*Weight in lbs.*	*Analysis % MoS_2*	*Content lbs. MoS_2*
Hand picked flake	83·5	88·18	73·64
Mica, wood, discarded	21·5	0·00	0·00
Size —1/16″	6485·0	1·09	70·84
Dust from collector	387·0	0·914	3·54
Totals and averages	6977·0	2·12	148·02

Size —1/16″ was fed to a Keedy sizer and the following sizes were made:—

Size	*Aperture*	*Weight Pounds*	*Analysis % MoS_2*	*Content Pounds MoS_2*
+20 s.w.		3162	1·57	49·64
+24 s.w.		618	0·66	4·08
+28 s.w.		494	0·518	2·56
+34 s.w.		299	0·770	2·30
+42 s.w.		310	0·481	1·49
+50 s.w.		359	0·63	2·26
+ 4 xx		409	0·592	2·51
+ 6 xx		170	0·607	1·03
+ 8 xx		169	0·550	0·93
+10 xx		159	0·601	0·96
+12 xx		88	0·505	0·44
+15 xx		67	0·481	0·32
+25 std		54	0·553	0·30
—25 std		127	1·59	2·02
Totals and averages, —		6485	1·09	70·84

The sizes coarser than 6 xx were run over a water concentrator using a slide feed on the coarser and a drop feed on the finer sizes. The sizes finer than 4 xx were put aside with the dust from the dust collector for test work on oil flotation.

Run No. 2.

10,000 pounds of the ore of lot No. 1 were taken and fed to the jaw crusher at 1″ opening. From the crusher it went to rolls at ½″ opening and unto a Fer-

raris screen fitted with $\frac{1}{8}''$ and $\frac{1}{16}''$ screens. Two men were placed on each side of the screen to hand pick any flake that was freed from the gangue as it passed over the screens. The oversize $\frac{1}{8}''$ was sent to rolls at $\frac{1}{4}''$ opening then at $\frac{1}{8}''$ and $\frac{1}{16}''$ until the entire lot passed the $\frac{1}{8}$ inch screen.

From the above operations the following products were obtained:—

Product	*Weight Pounds*	*Analysis % MoS_2*	*Content Pounds MoS_2*
Hand picked flake	67·5	88·18	59·54
Wood, mica discarded	12·0	0·00	0·00
Size—$\frac{1}{8}''$ + $\frac{1}{16}''$	4049·0	1·51	61·14
Size—$\frac{1}{16}''$	5666·0	0·968	53·96
Dust from collector	260·0	0·924	2·40
Totals and averages	10,054·5	1·77	177·04

Size —$\frac{1}{8}''$ + 1–16″ was run over the water concentrator and size —1–16″ was sent to the Keedy sizer from which the following sizes were obtained:—

Size Aperture	*Weight Pounds*	*Analysis % MoS_2*	*Content Pounds MoS_2*
+20 s.w.	2583	1·39	35·90
+24 s.w.	536	·778	4·17
+28 s.w.	415	·657	2·73
+34 s.w.	223	·657	1·47
+42 s.w.	260	·560	1·46
+50 s.w.	354	·535	1·89
+ 4 xx	310	·413	1·28
+ 6 xx	165	·486	0·80
+ 8 xx	168	·535	1·89
+10 xx	171	·632	1·08
+12 xx	76	·486	0·37
+15 xx	144	·511	0·74
+25 std	72	·438	0·31
—25 std	95	·900	0·86
Totals and averages	5572	0·968	53·96

The sizes coarser than 6 xx were run over a water flotation concentrator using a slide and belt feed on the coarser and a drop feed on the finer sizes. The sizes finer than 4 xx were put aside for test work on oil flotation. The dust from the collector was also held for further tests on oil flotation.

Run No. 3.

The ore used in this run was supposed to be run of mine and should reprseent the grade to be expected from actual milling operations. The total weight of the lot was 18,847 pounds. It was crushed, rolled, and sized in a similar manner to Run No. 2, The following products were obtained from which the analysis of the ore was calculated:—

Product	*Weight Pounds*	*Analysis % MoS_2*	*Content Pounds MoS_2*
Hand picked flake	72·5	88·18	63·93
Wood, mica discarded	6·5	0·00	0·00
Size —⅛″ + 1/16″	7578·0	0·878	66·53
Size —1/16″	10415·0	0·601	60·16
Dust from collector	378·0	0·341	1·29
Clean up of sizer	170·0	0·536	0·91
Totals and averages	18,620·0	1·04	192·82

Size —⅛″ + 1/16″ was run over the water concentrator and size —1/16″ was sent to the Keedy sizer. The dust and clean up of the sizer was held for further tests on oil flotation.

The following sizes were obtained from the run of the —1/16 inch material through the Keedy sizer:—

Size	*Aperture*	*Weight Pounds*	*Analysis % MoS_2*	*Contents Pounds MoS_2*
+20 s.w.		4637	1·02	47·30
+24 s.w.		861	·415	3·57
+28 s.w.		792	·341	2·71
+34 s.w.		383	·317	1·21
+42 s.w.		488	·283	1·38
+50 s.w.		558	·051	0·29
+ 4 xx		762	·293	2·22
+ 6 xx		296	·122	0·36
+ 8 xx		279	·098	0·20
+10 xx		270	trace	0·15
+12 xx		163	·171	0·28
+15 xx		206	·098	0·20
+25 std		107	·048	0·05
—25 std		189	·097	0·18
Totals and averages		9991	0·601	60·16

The sizes coarser than 6 xx were run over the water flotation concentrator, using a belt feed on the coarser and a drop feed on the finer sizes. The sizes finer that 4 xx were put aside for test work on oil flotation.

The first concentrates from the water flotation concentrator, run No. 1, No. 2, and No. 3, were mixed together and run through the Keedy sizer. Size + 8 mesh which was too coarse for the Wilfley roaster was repassed over the flotation machine and 142·25 pounds of concentrates were obtained. The tailings were crushed to pass through 8 mesh and added to the finer sizes. These tailings carried high values in molybdenite. The first flotation tailings, however, gave an analysis below 0·2% MoS_2.

The first concentrate through 3 mesh was roasted in a Wilfley Roaster, an oxidizing roast being given, the temperature being kept down below 10·50° F. After roasting the concentrates were resized and run over the flotation concentrator.

The second concentrates obtained were:—

Weight.................................155 pounds
Analysis..............................71·01% MoS_2.

The second tailings obtained were:—

Weight	1075 pounds
Analysis	0·536% MoS_2.

The second concentrates were rerun, after drying, over the flotation concentrator and a *third* concentrate obtained of 109 pounds, with an analysis of 81·64% MoS_2.

Summary.

Crude ore:—	
Weight	35651·5 pounds
Analysis	1·41% MoS_2
Content	504·25 lbs. MoS_2
Coarse mica and chips, discarded in crushing:—	
Weight	40 pounds
Analysis	0·00% MoS_2
Content	0·00 lbs. MoS_2
Dust from collector held:—	
Weight	1095 pounds
Analysis	0·743% MoS_2
Content	8·15 pounds MoS_2
Finer sizes held:—	
Weight	2235 pounds
Analysis	0·560% MoS_2
Content	12·55 pounds MoS_2
Hand picked flake:—	
Weight	223·5 pounds
Analysis	88·18% MoS_2
Content	197·11 lbs. MoS_2
Flotation concentrates:—	
Weight	251·25 pounds
Analysis	81·64% MoS_2
Content	205·12 lbs. MoS_2
Flotation middlings:—	
Weight	46 pounds
Analysis	37·55% MoS_2
Content	17·27 pounds MoS_2
Flotation 2nd tailings:—	
Weight	1075 pounds
Analysis	0·536% MoS_2
Content	5·76 lbs. MoS_2
Flotation 1st tailings:—	
Weight	30,685 pounds
Analysis	0·19% MoS_2
Content	58·3 lbs. MoS_2

Recapitulation.

	%	Pounds
Total molybdenite in crude ore	1·41	504·25

	% of Total	Pounds
Total molybdenite in flake	39·10	197·11
" " in flot. concentrate	40·68	205·12
" " in middling	3·43	17·27
" " in 2nd tailing	1·14	5·76
" " in 1st tailing	11·56	58·30
" " in dust not treated	1·61	8·14
" " in fines not treated	2·48	12·55
Totals	100·00	504·25

Slocan Star Mine, Slocan, B.C.

A small shipment of 465 pounds of zinc concentrates was received at the Ore Testing Laboratories, from Oscar V. White, Esq., general manager of the "Slocan Star" mine, Slocan, B.C.

A sample taken showed it to contain:—

Zinc	32·93%
Lead	3·27%
Iron	15·77%
Insoluble	6·36%
Silver	15·24%

Concentration tests were made on the Ullrich wet magnetic separator to obtain a separation of the zinc from the gangue, which, on examination, was found to be principally siderite, the iron carbonate. Siderite is slightly magnetic; zinc blende, containing 8 to 10% iron, weakly magnetic. It was, therefore, a question of adjusting the separator to remove the siderite without carrying with it too much of the weakly magnetic black jack.

Run No. 1: 65 pounds of the concentrate were taken and run through the separator with the rings in the following positions:—

Ring No. 1, (outside)	¾" from feed plates
Ring No. 2,	⅝" from feed plates
Ring No. 3,	½" from feed plates
Ring No. 4, (inside)	½" from feed plates

The current strength used on the magnets was 10 amperes, 110 volts.
The rate of feed was 65 pounds in 13 minutes.
The magnetic product obtained was 5·5 pounds.
The zinc product obtained was 57·5 pounds.

This test showed that the magnetic flux was too weak. The products were dried, mixed thoroughly, and the separator rings lowered for run No. 2.

Run No. 2: The separator rings were placed in the following positions:—

Ring No. 1, (outside)	⅝" from feed plates
Ring No. 2,	⅝" from feed plates
Ring No. 3,	½" from feed plates
Ring No. 4, (inside)	⅜" from feed plates

The current strength on the magnets was 10 amperes, 110 volts.
The rate of feed was 63 pounds in 12½ minutes.
The magnetic product obtained was 14 pounds.
Analyses:—
Zinc.................................12·39%
Iron.................................26·59%
The zinc product obtained was 47 pounds.
Analyses:—
Zinc.................................38·52%
Iron.................................12·88%
Recovery of zinc values in zinc product: 90%.

In the above test the stuff off the rings was added to the zinc product. In run No. 3 this was considered as a middling product, to be returned to the feed.

Run No. 3: The rings were adjusted to the following positions:—
Ring No. 1, (outside)....................½″ from feed plates
Ring No. 2,..............................½″ — 1/16″ from feed plates
Ring No. 3,..............................⅜″ from feed plates.....
Ring No. 4, (inside).....................⅜″ — 1/16″ from feed plates
The current strength on the magnets was 10 amperes, 110 volts.
Two hundred pounds of fresh concentrates were fed to the separator in 12 minutes.
The magnetic or iron products obtained were:—
From Ring No. 1..............................23·25 pounds
From Ring No. 2.............................. 4·75 pounds
From Ring No. 3..............................11·50 pounds
From Ring No. 4..............................14·50 pounds..

A total of...................................54 pounds

Analysis of magnetic iron product:—
Zinc.................................13·06%
Lead................................. 1·95%
Iron.................................25·28%
The sluff off from the rings or middling product was 52 pounds.

Analysis:—
Zinc.................................37·65%
Lead................................. 3·02%
Iron.................................12·64%
The zinc product obtained was 83·5 pounds.
Analysis:—
Zinc.................................41·35%
Lead................................. 4·01%
Iron.................................11·12%

More water was used in this test than in the former ones. The rate of feed was much faster, the result being that considerable middling was made to be returned to the feed. It was also noted that the magnetic product from ring No. 2 was much less than that from the other rings. This ring wa slowered 1/16″ for run No. 4.

Run No. 4: The separator rings were placed in the following positions:—
Ring No. 1, (outside)....................½″ from feed plates
Ring No. 2,..............................½″ — 1/16″ from feed plates

Ring No. 3,.............................$\frac{3}{8}''$ from feed plates
Ring No. 4, (inside).....................$\frac{3}{8}''$ — $\frac{1}{32}''$ from feed plates
Current strength on the magnets: 10 amperes, 110 volts.
Weight of feed: 192 pounds of fresh concentrates.
Rate of feed: 192 pounds in 40 minutes.
Middlings repassed until only two products made.
Magnetic or iron product obtained: 53 pounds.
Analysis:—
Zinc....................................18·60%
Iron....................................25·98%
Zinc product obtained: 130 pounds.
Analysis:—
Zinc....................................41·70%
Iron....................................12·03%

Less water was used than in run No. 3, the feed was much slower, consequently there was much less middling to be returned to the feed.

It will also be here noted that the point has been reached where the black jack is being carried by the rings into the magnetic product. Some of the larger particles of black jack are as magnetic as the siderite, and are carried over in any case, but run No. 4 shows that a point has been reached where the siderite is practically all out and a small quantity of the zinc blende is also being carried over by the rings.

Run No. 5: All products from the former tests were mixed together thoroughly and fed to the separator, with the rings in the same position as run No. 4. The stuff from off the rings was returned to the feed.

Current strength..............................10 amperes, 110 volts
Weight of feed................................420 pounds
Time of feed..................................80 minutes
Middlings returned............................40 pounds

Magnetic product obtained:—

From Ring No. 1...............................40·00 pounds
From Ring No. 2...............................29·25 pounds
From Ring No. 3...............................27·25 pounds
From Ring No. 4...............................21·00 pounds

A total of....................................117·50 pounds

Analysis:—
Zinc....................................12·70%
Lead....................................2·06%
Iron....................................25·88%
Insoluble...............................5·02%
Silver..................................8·58 oz.

Zinc product obtained: 301·5 pounds.

Analysis:—
Zinc....................................40·83%
Lead....................................3·67%
Iron....................................12·64%
Insoluble...............................6·88%
Silver..................................18·70 oz.

Product	Wt. lbs.	% by Wt.	Analysis					Content					Percentage of Total				
			Zinc %	Lead %	Iron %	Insol. %	Silver %	Zinc %	Lead %	Iron %	Insol. %	Silver %	Zinc %	Lead %	Iron %	Insol. %	Silver %
Iron—magnetic.	117·5	28	12·70	2·06	25·88	5·02	8·58	14·92	2·42	30·41	5·90	0·504	10·8	17·9	44·4	22·1	15·2
Zinc—non-magnetic........	301·5	72	40·83	3·67	12·64	6·89	18·70	123·10	11·07	38·11	20·77	2·819	89·2	82·1	55·6	77·9	84·8
Total......	419·0	100	32·94	3·22	16·35	6·36	15·86	138·02	13·49	68·52	26·67	3·323	100·0	100·0	100·0	100·0	100·0

The total obtained by calculation from the iron and zinc products is slightly different from the analysis of the original concentrate. This is due to the samples from former runs not being taken in proportion, more of the iron products being cut out for samples in proportion to that of the zinc products, hence the higher calculated analysis.

The total obtained by calculation from the iron and zinc products is slightly different from the analysis of the original concentrate. This is due to the samples from former runs not being taken in proportion, more of the iron products being cut out for samples in proportion to that of the zinc products, hence the higher calculated analysis.

A sample of the magnetic iron product was screened on a 20 mesh screen, and the material through 20 mesh was sampled. Analysis of this sample showed it to contain:—

Zinc	8·61%
Iron	28·91%

This sample was taken to indicate what results might be obtained by crushing the original concentrate to 20 mesh before passing it through the magnetic separator.

W. B. Timm.

The Hunt Molybdenite Mine.

The Hunt mine is situated on lots 8 and 9, concession XI, in the township of Brougham, county of Renfrew, Province of Ontario. It is 11 miles from Ashdod station on the Kingston and Pembroke railway.

The property, with several adjoining claims, is owned by the Renfrew Molybdenum Mines, Ltd., a subsidiary company of the Algunicon Development Company.

This property is in a more advanced stage of development than any other molybdenite mine in Ontario, and, probably, in Canada. The ore outcrops along the south side of the Mount St. Patrick ridge, and follows the mountain ridge, striking northeast and southwest. The main, or No. 1, vein has been traced a distance of 360 feet by opencuts and stripping, and will average 6 feet wide throughout that distance. On the surface, the vein material lies between the pegmatite granitic gneiss and limestone. There is no well defined footwall, the vein material in many places being very irregular, and penetrating the wall rock. The molybdenite does not occur in such large crystals as are found on the Spain property, but is more evenly disseminated throughout the vein material, which consists of pyrite, pyrrhotite, and pyroxenite. Mica is noticeable in the surface ore, but does not occur to much extent in the ore from the underground workings. The crystal flakes range between $\frac{1}{4}''$ and $1''$ in diameter.

Mining operations have been carried on intermittently since 1912. Besides the surface cuts and trenching work, an adit tunnel has been driven 92 feet into the hillside. At this point the vein was encountered, and after cutting 12 feet of vein the cross-cut was driven for 26 feet farther. Contrary to the surface indications, crystalline limestone was encountered on both walls of the vein. The adit cross-cuts the vein at a point 80 feet on the incline below the surface. Drifts have been driven in both directions from the cross-cut along the strike of the vein, thus proving a block of ore 120 feet long, with an average width of 6 and a depth of 80 feet.

Assuming that the ore in place will average 10 cu. ft. to the ton, and that it will contain 1% molybdenite, there is blocked out $\frac{120 \times 6 \times 80}{10} = 5{,}760$ tons, containing 57·6 tons of pure molybdenite.

Assuming that 80% of the total molybdenite is extracted, there would be recovered from this block of ore 46 net tons of pure molybdenite.

This tonnage of molybdenite at the present market prices has a gross value of $1 approximately per pound, or a total of $92,000.

It will also be noted that the outcrop of No. 1 vein has been stripped on the surface, and cut in several places, exposing the vein at these points over a length of 360 feet. As only 120 feet of this length has been figured as ore actually blocked out, there remains 240 feet of probable ore, which, if estimated at 6 feet wide and 60 feet on the incline, would yield an additional 8,640 tons, containing 86·4 tons of pure molybdenite, of which 69 tons would be recovered with a gross value of $138,000. As the outcrop is strong and well defined, there is every probability of this amount of ore being blocked out by the extension of the drifts from the adit cross-cut.

As the vein is strong, showing an average width of 6 feet in the adit level, it is reasonably certain that the ore extends below this level. We will not, however, take into account this possible ore.

In addition to the tonnage that could be expected from the No. 1 vein, the company have several other outcroppings on this and adjoining properties, from which a small tonnage might be expected. However, any additional tonnage from the various outcroppings can only be taken as possible ore and will, therefore, be omitted from the tonnage calculations.

The mine buildings, which are of excellent construction and equipment, consist of a large staff house, bunk and mess house to accommodate 50 men, a foreman's cottage, assay office, blacksmith's shop, and stables.

Development work was accomplished by hand-drilling. Mining machinery was ordered, and when operations were suspended the boiler, compressor, and hoisting engine had arrived at Ashdod station, where they are now stored.

A considerable tonnage of ore has been broken from the open-cuts on the hillside, and from the underground drifts. No shipment of picked flake has been made. The only shipments so far made have consisted of a few tons of milling ore, for testing purposes.

W. B. Timm.

Molybdenite Ore, from J. H. Cameron.

Two small lots of ore were received, one weighing 228 pounds and the other 58 pounds.

The greater part of the molybdenite was in small flakes disseminated through a gangue consisting mainly of quartz and pyroxenite. There was very little pyrite and no mica associated with the molybdenite.

Each of the above lots of ore was crushed separately in a small set of rolls to pass a 20 mesh screen. They were then fed to the Wood flotation machine.

Lot No. 1.—weight 228 pounds.

Concentrate No. 1—made	1·75	pounds
Middling No. 2—made	2·25	"
Middling No. 2—made	5·00	"
Tailing —made	185·00	"
Total of products	194·00	"
Loss of weight due to slime, etc.	34·00	"

Lot No. 2.—weight 58 pounds.

Concentrate No. 1, made	0·375	pounds
Middling No. 1,—made	1·000	"
Middling No. 2,—made	0·500	"
Tailing made	50·000	"
Total of products	51·875	"
Loss due to slime, etc.	6·125	"

The concentrates from lots 1 and 2 were combined and retreated on the flotation machine. The middlings, from lots 1 and 2 were combined with the middling and tailing from the retreatment of the concentrate and the whole was sampled as a middling product. This gave the following final results:—

	Lbs. Weight	% MoS_2	Lbs. of MoS_2	P. c. of Total MoS_2
Original ore fed to flotation machine lot No. 1..	228·	·89	2·546	100·00
" " " " No. 2...	58·			
High grade concentrate obtained..............	0·44	73·36	0·323	12·68
Combined middling products..................	10·00	8·64	0·864	33·95
Combined tailing lots 1 and 2.................	235·00	0·235	0·552	21·69
Hand picked flake..............................	0·25	90·00	0·225	8·84
Total..	245·69	....	1·964	17·16
Losses..	40·31	....	0·582	22·84

It will be noted that 22.94 per cent of the molybdenum sulphide (MoS_2) in the original ore fed to the machine was lost during the test. In handling such small quantities of ore over the large flotation machine it is practically impossible to prevent a large proportional loss.

The above figures do not truly represent how the ore will concentrate. It would require a very much larger sample to satisfactorily establish the maximum percentage of the molybdenite which could be recovered as a concentrate averaging over 80 per cent (MoS_2).

As far as can be judged from such a small sample the ore is adaptable to the flotation process and a fair recovery of the molybdenite could be expected.

The fact that the ore contains very little pyrite is encouraging as the treatment is generally simplified by the absence of that mineral.

C. S. Parsons.

The Spain Mine.

The Spain mine is situated on lots 30 and 31, concession IV, in the township of Griffith, county of Renfrew, Province of Ontario. It is 29 miles from the town of Renfrew, and 19 miles from Caldwell station on the Ottawa and Parry Sound branch of the Grand Trunk railway.

The property was bought by William J. Spain of New York, from Joseph Legree of Renfrew, Ontario. Mining operations commenced about April 1st, 1915.

The vein outcrops on the top of a ridge of gneiss on the south side of the Mount St. Patrick range. The vein material consists of a dike or dikes of pegmatite granite cutting a zone of metamorphosed gneiss lying between the gneiss and the limestone. This dike formation is 100 feet wide in places, the average width being about 50 feet. The strike is northeast and southwest. The dip is southeast about 15° from the horizontal. The molybdenite does not occur throughout the dike, but only along numerous seams and jointing planes that traverse the dike in all directions. Pyrite, pyrrhotite, and pyroxenite are found associated with the molybdenite, but little or no mica is present. The molybdenite crystals are very large, the average being about 2″ in diameter. Exceptionally large crystal flakes are found, 6″ long and 4″ wide. The crystals split easily into flakes as thin as tin foil.

The workings to date consist of two open cuts and a shaft, 6′ by 9′, sunk to a depth of 50′, to fulfil a contract agreement with the original owner. The shaft was started on two or three small stringers of molybdenite, but was sunk for almost the entire depth through the footwall of gneiss. Along the strike of the vein the dike formation has been cut in several places by trenches from 3 to 6 feet deep. The most of these trenches show molybdenite. The dike can be traced for hundreds of feet on both sides of the open cuts.

From the ore broken in the opencuts there has been obtained by hand-cobbing, 5 tons of flake molybdenite (approx. 95% MoS_2), which was shipped to U. S. points before the embargo, and there are stocked at the mine between 4,000 and 5,000 pounds of flake molybdenite (approx. 95% MoS_2) ready for shipment. Besides the hand picked flake, there is on hand the following stock of milling ore:—

30 tons of	2% ore, content:	1,200 lbs. MoS_2
720 tons of	2% ore, content:	28,800 lbs. MoS_2
100 tons of	2% ore, content:	4,000 lbs. MoS_2
30 tons of	12% ore, content:	7,200 lbs. MoS_2
8·5 tons of	10% ore, content:	1,700 lbs. MoS_2

A total of 888·5 tons of milling ore, with a content of 42,900 pounds of pure MoS_2. Summing up, we have a total content of approximately 29 tons of pure MoS_2 in the ore extracted from the open cuts.

No estimation can be made of the ore in sight. There is no ore actually blocked out. Molybdenite shows in the open cuts and other trenches. Whether this is consistent in depth and in lateral extent only development will prove. However, there appears to be a large dike body, which, when broken, will produce 80% waste, to be removed at once, and 20% milling ore.

The present equipment consists of:—

One 40 H. P. boiler.

One double drum hoist.

One No. 7 Cameron sinking pump.

Three Rand jack hammer drills.

The mine buildings consist of:—

One large sleeping house to accommodate 50 men.

One large staff house.

One dining house.

One office.

One blacksmith's shop.

One boiler and hoist house.

One stable.

A saw-mill is being erected to furnish lumber for the milling plant and other buildings. Cement has been ordered for the foundation of the milling machinery. The heavy milling machinery has also been ordered. The construction on the mill will be commenced as soon as supplies can be delivered.

Mr. Spain has staked several other claims in the district. Surface indications on some of them are very promising.

W. B. Timm.

Report on G. M. Macdonnell's Molybdenite Ore, from Mountain Grove, Frontenac County, Ontario.

Character of Ore.-

The molybdenite was associated with a gangue consisting chiefly of pink feldspar and pyroxene. Very little pyrite and no mica was observed in the sample.

Crushing.

The ore was crushed in a small set of rolls until the whole passed through a 20 mesh screen (operative).

Concentration.

The above product was then fed to the Wood flotation machine without further sizing.

Weight of ore fed to machine	238 lbs., 00 oz.
Concentrate	00 lbs., 14 oz.
Middling	07 oz.
Tailing	191 lbs., 00 oz.
Loss (chiefly due to slime)	45 lbs., 11 oz.
Total	238 lbs., 00 oz.

The concentrate was dried and then screened over an 80 mesh screen in order to eliminate the dust and fine pyrite, which had floated off with it.

The product in the 80 mesh screen was classed as a high grade concentrate and the product passing through the screen as a middling.

The weights of the two products were as follows:—

Concentrate 80 mesh product was added to the middling from the flotation machine and the combined product was then sampled as a middling.

In practice this middling product would either be returned with the feed to the flotation machine or treated on separate machines.

The final results were as follows:—

	Weight	MoS_2	Weight of MoS_2 lbs.	% of Total MoS_2
Fed to flotation machine	238 lbs. 00 oz.	0·4%	0·952	100·00
Concentrate	00 " 06 "	69·09	0·259	27·20
Middling	1 " 00 "	7·89	0·079	8·30
Tailing	191 " 00 "	0·07	0·134	14·07
Total of products	192 " 06 "		0·472	49·50
Loss	45 " 10 "		0·480	50·40

Conclusion.

It will be noted that there was 50·4 per cent of the molybdenite in the original ore fed to the flotation machine which is not accounted for in the products. In handling such a small quantity of ore over the large machine it is impossible to prevent a proportionately large loss. For instance—taking the above concentrate—it would be quite possible to have lost say 6 oz. while collecting and drying it. Such a small loss of weight along would practically account for the 50·4 per cent loss.

Although the above figures, due to the large loss, do not represent how the ore will concentrate, they are of value in that they show the ore is adaptable to the flotation process.

C. S. Parsons.

FUELS AND FUEL TESTING DIVISION.

I

WORK AT FUEL TESTING STATION.

B. F. Haanel,
Chief of Division

The work of the Division of Fuels and Fuel Testing during the fiscal year ending March 31, 1916, consisted in the carrying out of 19 boiler tests on 8 commercial samples of coal and 1 of peat, and the testing in the gas producer of 5 samples of coal. The coals tested for steaming purposes were obtained from the West Canadian Collieries, "Bellevue"; West Canadian Collieries, "Greenhill"; McGillivray Coal and Coke Co., "Coleman"; Franco Canadian Collieries, "Frank"; Yellowhead Pass Coal and Coke Co.; Jasper Park Collieries, "Miette Mine"; Drumheller Coal Co., Ltd., "Drumheller"; Georgetown Collieries, Ltd., "Georgetown". The commercial samples of peat tested were obtained from the peat plant operating at Alfred, Ont.

The coals tested in the gas producer were obtained from the Franco Canadian Collieries, "Frank"; West Canadian Collieries, "Bellevue"; Rosedale Coal and Clay Products Co., "Rosedale"; Chinook Coal Co., Ltd., "Chinook"; Georgetown Collieries, Ltd., "Georgetown". All the coals tested in the boiler and producer were obtained from mines operating in the province of Alberta.

Four commercial samples of coal received at the Fuel Testing Station during the fiscal year 1915–16, remain to be tested in the producer, viz: Midland Collieries, Ltd., "Midland"; Rosedale Coal and Clay Products Co.; Chinook Coal Co. Ltd.; Hillcrest Collieries.

In addition to these commercial samples of coal, the detailed investigation of which involved much chemical work, the chemical laboratory received for analysis, proximate, ultimate, or both, and determination of heating value, 90 coals and 52 peats; for chemical analysis and physical examination, 32 oil or gasoline samples; and for general analysis, 28 ash, 5 graphite, 4 trinitrotoluene, and 3 miscellaneous samples.

The analysis of mine air samples obtained from the various operating coal mines of the Dominion, which was begun the previous year, has grown to such proportions that this work alone requires the undivided attention of a chemist specially qualified to make the required analyses. During the fiscal year 172 mine air samples were received and analyzed. Of this number 42 were received from the province of Alberta, 74 from British Columbia, and 56 from Nova Scotia. The samples were taken from 69 mines operated by 29 different operators. The information afforded by the analyses of mine air is of unquestioned importance to the mine operators, inasmuch as such information indicates where defective ventilation exists, parts of mines which are unsafe to work in, and in general tends towards the safeguarding of the lives of the labourers, since many of the mine disasters have been directly traced to defective ventilation which leads to explosions. In order, however, to permit the miners to receive the full benefit of such analyses, the samples should be analyzed as soon as received, and the results reported without delay.

If this class of work is to be most effective, and of the greatest value to the mine operators, it is necessary that the provincial mine inspectors should take

samples whenever the conditions in a mine suggest any possibility of danger from fire damp explosion, or from poisonous gases. When analyses show the conditions to be bad, samples should be repeatedly taken until the conditions are corrected. The laboratories of the Fuel Testing Station are now fully equipped to conduct analyses and other investigations which may be required, of mine air, and the analyses of all samples sent to the laboratories will be immediately undertaken when the contemplated increase in the chemical staff of this Division permits the entire or major portion of the time of one man to be devoted to this work.

Research Work. On account of the large increase in the routine work of this Division, and expansion of its scope to include the analyses and examination of fuels and oils required by the various departments of the Government, and the undertaking of new work in the interest of the coal operators—as described above—it has been impossible to undertake, to any extent, research work. The solutions of certain economic problems in connexion with the development, marketing and utilization of certain of the western fuels, require that much research work be undertaken. Research work of this character—to accomplish the desired result—requires the almost continuous application of the services of a fully qualified research chemist, and it is hoped that this Division will be in a position—after a short time—to carry to completion the investigation already commenced in connexion with the problem of briquetting Western lignitic coals and also the feasibility of utilizing certain of them as a source for oil. An investigation will shortly be commenced which will have as its objective the determination—if possible—of an economic and commercial process for the extraction of the bitumen from the tar sands of Alberta, and also the feasibility of using these sands as a source of oil.

Machine Shop. Since the inauguration of the machine shop at the fuel testing station, the demand upon the shop for construction of special experimental machines, the repairing or alterations of existing machines and apparatus, and the erection of new plant at both the Mines Branch experimental laboratories at Sussex street and the Ore Dressing and Concentrating laboratories, has become so great that in order to keep abreast of the work, the staff of machinists had to be increased. The accompanying report of the mechanical superintendent sets forth in detail the extent and variety of the work done and the costs of the various pieces of machinery. It will be seen from the perusal of the above report that the installation of the machine shop, in addition to facilitating the experimental work of the laboratories, also effects a very appreciable economy. The same work, if done by outside parties would cost considerably more.

Investigation of Peat Bogs. During the summer months Mr. Anrep surveyed the following peat bogs: Moose Creek, Westmeath, and Meath. In addition to his field work he also prepared the maps and report of the summer's work.

The technical staff of the Division of Fuels and Fuel Testing has been employed in conducting the 72 hour continuous producer tests and boiler tests, and in working up the results of tests and preparing reports embodying the results obtained.

The staff of chemists was increased in May by the temporary appointment of Mr. J. B. Robertson. Mr. T. W. Hardy resigned at the end of November, and his successor, Mr. V. F. Murray, was not appointed until February, 1916.

The summary reports of Messrs. Stansfield, Anrep, and Mantle, are herewith subjoined.

II

CHEMICAL LABORATORIES OF THE FUEL TESTING STATION.

Edgar Stansfield,

Chemist in Charge.

The laboratories of the Fuel Testing Station were utilized during the year for the chemical work of the Division of Fuels and Fuel Testing; and, in addition, for the chemical work of the Division of Ore Dressing and Metallurgy, under the immediate supervision of Mr. H.C. Mabee. Dr. F. E. Carter, Mr. J. H.H. Nicolls, and Mr .T. W. Hardy were engaged in the work of fuel testing and in the examination of oils, gases, etc. Mr. Hardy also assisted Mr. Mabee in the work of the Ore Dressing Division. Mr. J. B. Robertson, who was temporarily employed to assist with the large amount of routine work in arrears, devoted considerable of his time to the analysis of mine air after the work in arrear had been completed.

The laboratory accommodation has been increased to a small extent by the transference of the sampling equipment, formerly installed in a room on the ground floor, to a special room in an outside building. This change permitted the former room to be equipped and used for the analyses of mine air samples.

The equipment has been increased by the purchase of the following special apparatus: Riche Adiabatic calorimeter, ¼ H. P. steam boiler, oil distillation apparatus, vacuum distillation apparatus, and glass parts for a new gas analysis apparatus; also by apparatus received from Queen's University, originally purchased for the work there of Dr. Kalmus on cobalt. This apparatus included a Hoskins crucible furnace, Fery pyrometer, pressure gauge, platinum filter cones, rheostat, ammeters, and voltmeters. In addition to the above, the following new apparatus or improvements to old apparatus, have been designed and wholly or partly made on the premises: total heat attachment to Boys gas calorimeter, steam superheater, modified form of Graham and Winmill's apparatus for the determination of carbon monoxide, changes and additions to Burrell's mine air analysis apparatus, and two tile-topped iron tables. Twenty two volumes have been added to the library, as well as a large number of reports, bulletins, and journals.

The total number of samples submitted for analysis during the year, exclusive of the many routine gas samples of which no count is kept, was 146 per cent larger than in 1914. If, however, mine air samples are also excluded, as none of these were received prior to 1915, the increase still amounts to 36 per cent. It is worth noting that this is largely due to the steadily increasing use which is made of this laboratory by government departments other than the Department of Mines. On the other hand, miscellaneous samples sent in by outsiders, the least important work of the laboratory, show a marked decrease. The arrears of routine work mentioned above were entirely caught up during the year, and a beginning was made with some of the special investigations needing attention, so that the total output of work during 1915 was far in excess of that of 1914 which in turn was far greater than the work of 1913.

The samples received include 172 mine air, 90 coal, 52 peat, 32 oil or gasoline, 28 ash, 5 graphite, 4 trinitroluene, and 3 miscellaneous samples. One hundred and seventy two of the above samples were received in connexion with the testing of mine air, 61 from the regular laboratory work of the Fuel Testing Division, 47 from field parties of the Mines Branch, 28 from the Department of Militia and Defence, 25 from the Board of Railway Commissioners, 11 from the Geological Survey, 10 "official" coal mine samples, by arrangement, from the Chief Inspector of Mines for the Province of Alberta, 7 from the Department of Naval Service, 4 from the Shell Committee, 2 from the Public Works Department, 2 from the Department of Marine and Fisheries, and 17 from other parties.

A good deal of the work of the laboratory consisted of routine gas analysis in connexion with the 31 boiler trials and 8 producer trials carried out on the premises during the year. In this connexion it might be noted that some 36 samples of flue gas are required to be analysed during a regular twelve hour boiler trial. The determinations made during a producer trial include those of the composition and calorific value of the gases, together with their ammonia, tar, and water content; a four-days trial involving as many as 48 gas analyses, 48 determinations of calorific value, 15 of tar, 6 of water, and 6 of ammonia content. Each of these large scale trials also involves considerable work in the cleaning of apparatus, making up re-agents, re-standardizing gas meters, etc., as well as in the computing and reporting of all results obtained. The coal and ash samples involved are included in the enumeration of samples given above.

During the year 172 mine air samples were received, 42 from Alberta, 74 from British Columbia, and 56 from Nova Scotia. These samples came from 69 different mines belonging to 29 different operators.

For this work it is obvious that the samples should be analyzed as soon as received, and the results reported without delay. The work was unfortunately carried out under serious difficulties during much of the year and delays repeatedly occurred. Suitable apparatus was purchased, record and report forms and books printed, and care taken to systematize and expedite the work; but, as experience has been gained with this type of work, it has been found advantageous from time to time to modify and improve the apparatus originally purchased, and fresh apparatus has had to be designed and set up. Moreover, no chemist has been available to give his whole time to the work although from time to time two have had to be employed during the rush periods, and until November the analyses had to be made in a room unsuited for gas analysis of the great accuracy required. A room of equable temperature in the basement is now equipped, and is being used for this work. This extra room provides the necessary accommodation for a special chemist, and the urgent need for such a man is becoming increasingly apparent. All evidence indicates that the mine air samples are likely to come in more rapidly in the future than they have done in the past, and it is clear that they should do so if the work is to be of full value to the country in the prevention of accidents. A prompt handling of all samples will undoubtedly increase the interest taken by mine owners and mine inspectors in this work, and will materially increase its value.

Special work carried out during the year includes: the design and testing of new and modified apparatus referred to above; setting up and standardizing a platinum resistance thermometer for accurate calorimetry; calibrating two Beckmann thermometers; an investigation to determine the errors involved in the use of nickel lining for a bomb calorimeter; investigations into the methods of gas calorimetry and gas analysis employed in the laboratory; a preliminary investigation on the air drying of coal, begun March 1914, and still in progress, daily determinations being made; and the beginning of an investigation into the retorting and briquetting of western lignites. A new type of furnace for making ultimate analysis of carbon and hydrogen in fuels has been designed by the writer to overcome difficulties which have been met with in this work when using the regular apparatus, but, up to date, war conditions have prevented the receipt of some of the necessary parts and delayed its construction. A museum collection of the more important coals, cokes, and oils tested in the laboratory has been commenced. All samples received since the inception of work in these laboratories have now been carefully card indexed, and a special card index has also been prepared by means of which the mine air record of any mine can be seen at a glance. Report No. 323 "Products and By-Products of Coal", prepared by Stansfield and Carter in 1914,

was published in 1915; and a compilation of all coal analyses made by the writer and his assistants since the commencement of fuel testing under the auspices of the Mines Branch at McGill University in 1907, is now in preparation. Other reports and bulletins are urgently needed, but so far no time has been available for their production.

III

INVESTIGATION OF PEAT BOGS.

A. Anrep,

Peat Expert.

In accordance with instructions, a survey of peat bogs was carried on during the season of 1915, in order to determine the extent, depth, and different qualities of the peat contained in the various bogs.

This investigation started late in June, when the writer left Ottawa—with Mr. E. V. Gage as a temporary assistant—to perform the field work which was carried on during July, August, and part of September.

The following statement briefly summarizes the results of the season's investigation..

(1) *Moose Creek* peat bog is situated about 1½ miles northwest of Moose Creek about 2 miles northeast of Casselman, in the townships of Roxborough, South Plantagenet and Cambridge, counties of Stormont, Prescott and Russel, province of Ontario.

The total area covered by this bog is approximately 12,543 acres, with depth varying from 3 to 17 feet.

The Grand Trunk railway traverses the centre of the bog.

(2) *Westmeath* peat bog is situated about 1 mile south of Westmeath, 1¼ miles north of Beachburg, township of Westmeath, county of Renfrew, province of Ontario.

The total area covered by this bog is approximately 2,840 acres.

The Canadian Northern railway runs about 1¼ miles south of this bog.

(3) *Meath* peat bog is situated about ½ mile west of Meath station in the townships of Westmeath and Stafford, county of Renfrew, province of Ontario.

The total area covered by this bog is approximately 1,695 acres.

(4) An investigation was also commenced on the Snake River peat bog. This bog is situated about one-half mile south of Snake River station on the Canadian Pacific railway in the township of Westmeath, county of Renfrew, province of Ontario, and follows in a narrow strip, each side of the river towards Osceola. This investigation was not completed.

Inasmuch as a systematic investigation of a peat bog occupies considerable time, and as the appropriation for the season's investigations had been decreased to less than one-half the amount granted previous years, it was found impossible to investigate more than three bogs.

The total area investigated in Ontario for the season of 1915 comprised approximately 17,078 acres.

In September I attended, by request, the meeting of the International Joint Commission which was held in Warroad, Minn., U. S. A.

Detailed description, determination, and maps, will be published in a separate report.

IV

REPORT OF MECHANICAL WORK DONE AT FUEL TESTING STATION, ETC.

Fuel Testing Station,
Ottawa, Ont., April 18, 1916.

Sir,—

Herewith appended, please find an abstract of the records that have been kept showing the work done, with the amount of labour and material expended thereon; all arranged under the headings of the divisions to which they were charged.

As most of the apparatus constructed in our machine shop is necessarily experimental, several alterations were made on the different machines before they were finally completed.

I wish to call your attention to an important fact that, in having these machines constructed in our own machine shop, together with all necessary alterations and repairs, we not only gain in accuracy and despatch by having the work done on the premises, but we are, moreover, making a great saving, as outside firms would charge from $1.25 to $1.50 per hour for this class of work.

During the last fiscal year I was instructed to design and build a special stone chiselling machine for Dr. Parks of the Toronto University. These instructions were carried out, and the machine was shipped to Toronto. A statement showing the time and material expended on this machine is included in the enclosed report.

Yours obediently,
A. W. MANTLE,
Mechanical Superintendent.

B. F. Haanel,
Chief of Fuels and Fuel Testing,
Mines Branch, Dept. of Mines,
Sussex Street, Ottawa.

SUMMARY REPORT OF COST OF WORK DONE BY THE MACHINE SHOP FOR THE SEVERAL DIVISIONS OF THE MINES BRANCH.

Division of Fuels and Fuel Testing.

Labour and Material.

Fuel Testing:—	
Overhauling gas engine	$ 12.99
Re-arranging antipulsator in new position	31.06
Miscellaneous work done in connexion with gas producer and boilers	95.29
Making new tools for machine shop	10.18
Installing, shafting, machinery, etc., in fitting shop	90.39
Miscellaneous work done on small jobs	71.79
Chemical:—	
Making Mercury hoist No. 1	29.24
Making Mercury hoist No. 2	25.35
Making steam superheater, and connecting, etc	20.07
Making hoisting tackle for mine gas apparatus	27.54
Making new tile top angle iron tables for the furnace room	42.54
Moving and erecting machinery for sampling	23.10
Miscellaneous work done	62.75
	$542.29

Ore Dressing Laboratory.

	Labour and Material
Constructing, etc., No. 2 Mines Branch flotation machine	$ 579.82
Constructing, etc., wood ore machine	453.08
Constructing, etc., No. 1, Mines Branch flotation machine	475.41
Constructing, etc., oil flotation machine	121.12
Work in roaster building and on rotary roaster	181.62
Repairs to Ferris screen	4.40
Repairs to Baume planetary pulverizer	33.33
Repairs to ball mill	31.48
Repairs to Keedy sizer	12.42
Repairs to small laboratory oil flotation machine	5.03
Repairs to Ullrich machine	4.47
Miscellaneous work done	106.56
	$2,008.74

Carpenter Shop at Sussex Street.

Unloading, unpacking, etc., of Universal wood working machine	$ 59.44
Making tools for the U. W. W. machine	55.01
Miscellaneous work	.83
	$ 115.28

Mines Building, Sussex Street.

Making, erecting and adjusting elevator in bookstore	$ 79.00
Erecting universal testing machine	65.22
Miscellaneous work	86.08
	$ 230.30

Non-Metalliferous Mines Division.

	Labour and Material
Designing, construction, and alterations to stone chiselling machine	$ 263.59
Miscellaneous work	2.64
	$ 266.23

Metalliferous Mines Division.

Making angle iron motor bracket	$ 8.37

Chemical Division, Mines Branch.

Installing, etc., 1″ vacuum pump	$ 15.79
Making adjustable stand for microscope	20.33
Miscellaneous work	20.29
	$ 56.41

Ceramic Division, Mines Branch.

Work on Ball mill	32.32
Work on clay dies	8.70
Making laboratory elutriator	15.52
Installing grinding machinery	28.92
Work in connexion with distilled water tank	20.06
Work in connexion with rotary kiln	311.09
Making clay mould	10.61
Making two special pulleys	34.49
Making hand press	44.84
Miscellaneous work	140.31
	$ 646.86

CERAMIC DIVISION.

I

INVESTIGATION OF CLAY AND SHALE RESOURCES.

J. Keele,

Chief of Division.

The investigation of the clay and shale resources of the Dominion begun a few years ago, was continued in the field and laboratory by the members of the Ceramic Division.

While making a reconnaissance survey of the Western Provinces, it was found that fireclays, and stoneware or pottery clays were particularly abundant in the southern portion of the Province of Saskatchewan. It was essential that this region should be examined in detail; therefore Mr. N. B. Davis was instructed to carry on a systematic survey, and collect samples for testing purposes. He covered the greater part of the ground during the summer of 1915, and a brief account of his work is given in his report on that area.

During the early part of the summer, the writer made an examination of the valley of the Saugeen river, in the vicinity of Port Elgin, for the Hydro-electric Commission of Ontario, which has plans for the storage of water and development of power at that point. About a week was spent in the Moncton area, in the Province of New Brunswick, but the principal part of the field season was devoted to an examination of certain areas in northern and western Ontario, the following being a brief account of the materials in that region.

NORTHERN ONTARIO.

Pleistocene Clays.

Most of the superficial clays in this region are directly or indirectly of glacial origin, those of interest to the clayworkers being the stratified, stoneless clays, which occur in detached patches along river valleys or inlets near the north shore of Lakes Huron and Superior. These clays, for the most part, are red burning easily fusible varieties, suitable for the manufacture of common brick or drain tile, but not for vitrified wares.

They are worked at Sault Ste. Marie, Fort William, and Thessalon for making common brick only. A deposit of massive, stoneless, red clay, often of considerable thickness, occurs a short distance west of Fort William. It is exposed at intervals in cuttings along the Canadian Pacific and National Transcontinental railways for probably 8 or 10 miles. This clay is very plastic and smooth, but has a high shrinkage in drying and burning.

Stratified, stoneless, lake deposits, consisting of alternate layers of silt and clay, occur in a wide strip directly north of Lake Timiskaming, extending almost continuously on each side of the Toronto and Northern Ontario railway as far as the vicinity of Cochrane. Samples of this clay, collected at Haileybury, Heaslip, Matheson and Porquis Junction, were tested and found to be suitable for the manufacture of common brick and drain tile. The material in the vicinity of the National Transcontinental railway between Cochrane and Hearst consists mostly of stony, glacial clay, but at some points it appears to be sufficiently free from pebbles for brick or tile making. The clays in this region carry a high percentage of lime, and burn to buff or cream colours, with a rather porous body. No clay suitable for making vitrified ware was found.

Shale Deposits.

The plastic shales of the Cataract, Queenston, and Lorraine formations, which occur so abundantly in southwestern Ontario, reach their northern limit in Manitoulin island, where they are still of considerable thickness, and with outcrops easily available. Samples collected in this locality by Dr. M. Y. Williams of the Geological Survey were forwarded to the Ceramic Laboratory for examination. These materials are suitable for the manufacture of common and dry pressed brick or hollow ware.

The crystalline and metamorphic rocks which form the principal portion of the bed-rock of northern and western Ontario are practically void of any plastic material. Some of the rocks contained in them were originally shales, but are now altered to slates. An attempt was recently made to work the Animikie slates on the slopes of Mount McKay, near Fort William, but they were found to be too hard and gritty after grinding, even for making bricks in the powerful machine used in the dry pressed process. A good red colour was obtained in burning the slates, but the body was too soft and incoherent. As this slate is easily overfired and softened, it was impossible to burn the brick to the vitrification point.

A bed of plastic shale is said to exist in the Animikie formation outcropping on Sawyer bay, not far from Port Arthur.

Some of this material was brought by the Alsip Brick Company to their plant at Fort William, and made into dry pressed brick of good quality. A sample of this shale given to the writer was found to be plastic enough for moulding into hollow ware, and burning to a good, hard, red body at low temperatures.

Residual Clays.

Residual clay deposits, or those which have resulted from the decomposition of rocks in situ, are of rare occurrence in Canada, owing to the severity of the glacial scouring to which most of the country has been subjected.

Kaolins are the most valuable of the residual deposits, and they have been eagerly sought for during the past year. Kaolins are fine grained, highly refractory clays, of low plasticity, white in colour, both in the raw and burned state. The chief uses are connected with the pottery, paper, and paint industry.

Kaolin as mined is subjected to a washing process, in order to free it from quartz or mica impurities. The washed product is sold under the trade name of china clay, the market price for it being 8 to 12 dollars a ton, or sometimes more.

Several samples of residual clays were sent to the laboratory for examination, but none of them came up to the requirements of kaolin as they did not burn to a white colour, and many of them were not even refractory enough to be classed as low grade fireclays. Most of the residual clays, however, will stand higher temperatures than the Pleistocene surface clays, and may be used for the manufacture of better grade wares.

The most important occurrence of residual clay is reported by Mr. A. L. Parsons from the Helen mine at Michipicoten, where a large mass of diabase in contact with the iron ore has been kaolinized. It is described in the Twenty-fourth Annual Report of the Ontario Bureau of Mines, 1915.

The laboratory tests on this material were conducted by the writer, who found that the material, although being refractory, does not burn to a white colour. The clay was very plastic, and had good bonding properties in the raw state, so that it might be used as a mixture with crushed quartzite to produce silica brick.

Kaolin of white colour is said to occur on the north shore of Lake Superior. The deposit was revealed by the removal of gravel beds, which were shipped to Port Arthur and Fort William for structural purposes.

The fact that most of these soft residual deposits, which have escaped entire removal by glacial erosion, are concealed by an overburden of glacial drift adds considerable difficulty to the prospecting and exploitation of them. On the other hand, little or no prospecting has been done for kaolin; all this work has hitherto had only one object in view; the search for metallic minerals.

II

LABORATORY AND EQUIPMENT.

Experimental work was begun in October, 1915, in the Ceramic Laboratory at the Mines Branch building. Three rooms in the basement were fitted up for this purpose with a very complete equipment enabling the staff to obtain and furnish information required regarding the character and uses of raw materials.

The moulding room shown on Plate V contains work tables fitted with slate slabs for tempering, moulding and preparing test pieces by hand from small samples of clay or shale, also the following apparatus:

Hand press worked by lever for making bricklets by the dry pressed process.

Hand plunger press with 3 inch, round die, used for making field drain tile tests from small samples of clay.

Electric oven of 3 cubic feet capacity, with temperature range of 120 to 250 degrees Fahr., for testing the fast drying qualities of clays.

One enamelling muffle kiln, with gas and air blower for burning trials of glazes and enamels.

One round down-draft gas furnace, similar to the Seger rund-ofen, but larger, and capable of reaching a temperature of 1,300 to 1,400 degrees C. with natural draft. This furnace is used principally for determining the softening points of easily fusible clays.

A reverberatory type of gas fired kiln, which works on the same principle as the round furnace, but with a larger chamber in which the clay wares are exposed to the gas flame.

The kiln room proper, Plate VI which adjoins the moulding room, is at the rear end of the George street wing of the building, outside of the main wall. It is the largest room of the three used by the Ceramic Division, and as the ceiling is very high, is well adapted for kiln work where burning is kept up for long periods.

The kiln equipment consists of:—

One down-draft kiln lined throughout with firebrick, having a setting chamber of 15 cubic feet capacity and a fire box in which coal, coke or peat can be used when firing. This kiln is designed to give results closely approximating those obtained in burning commercial clay ware of the ordinary structural variety, such as brick, hollow-ware, drain tile, etc.

One Caulkin's special pottery kiln, 18″ × 20″ × 33″ inside measurement, for burning clay wares without contact with fire gases, or for glaze and enamel work. This kiln is used at temperatures varying from 960 to 1,200 degrees C., but is capable of reaching higher temperatures if necessary. The time of burning var es from 9 to 12 hours, the fuel used being kero ene oil, with natural draft. Both pyrometric cones and pyrometers are used for control of temperature while burning. The pyrometer equipment consists of platinum-rhodium thermocouples, enclosed in alundum and drawn-quartz tubes, and two portable millivoltmetres, graduated to 1,400 and 1,600 degrees Centigrade respectively.

The kiln room also accommodates some of the larger machinery and apparatus as follows:

One 3 foot dry pan, the bottom of which is provided with two sets of removable plates, one set perforated, and the other solid, so that it can be used for the dry grinding of shales and hard clays or for wet grinding and tempering. Alongside the grinding pan stands a small experimental auger machine. This machine is built on the same principle as all stiff mud machines used in commercial plants. It is fitted with a take-off or hand-cutting table, and a series of dies for making full sized brick, hollow-ware, drain tile, roofing tile, promenade tile, etc.

Both the grinding pan and auger machine are belt-driven by a 5 H. P. motor.

A hand plunger press using the same dies as the augur machine is provided for making tests from samples of clay which are not large enough to be moulded in the latter.

A hand screw press, made at the machine shop of the Mines Branch, turns out dry pressed floor and wall tile.

The clay washing apparatus consists of plunger, troughs, and settling tanks, made of galvanized iron.

The room is lighted by skylights during the day, and by 3—400 watt nitrogen bulbs by night.

The third room of the Ceramic Laboratory, Plates VII and VIII, contains the following pieces of apparatus:—

An electric resistance furnace, with its transformer and switchboard. This furnace is used for testing refractory clays or those which require a temperature of 1,500 to 1,800 degrees C. before softening, and for burning small test bricklets of various mixtures designed for refractory purposes.

One two-jar porcelain pebble mill, for grinding the raw materials of glazes and enamels, either wet or dry.

One two-cylinder cast iron pebble mill for grinding cement clinker or paint materials.

One eight-tube centrifuge for determining fineness of grain of pottery or paper clays.

One elutriating apparatus for washing small samples of kaolins or pottery clays.

In addition to the laboratories described above, a sample room, Plate IX, in connexion with the offices of the staff, is used for displaying various clay wares made in Canadian and foreign plants.

The object of this collection is to have a series of standard commercial clay wares with which to compare the results of tests made in the laboratory.

The room is also used for weighing, measuring, and recording, which forms a large part of the experimental work and testing of clays.

III

TESTING OF CLAYS AND SHALES.

Material for examination or testing comes to the laboratory from four sources:

1. Samples collected in the field by the members of the staff of the division while carrying on a systematic investigation of the clay and shale resources of the Dominion. The examination of these constitutes the largest part of the laboratory work.

2. Samples collected in the field by various members of the Mines Branch and Geological Survey.

3. Samples from Provincial Bureaus of Mines or Agriculture.
4. Samples from outside sources, such as industrial firms or private individuals.

Up to the present, no charge has been made for testing clays, and a considerable amount of free work has been done. Considering the present status of the clay industry in Canada, it seems advisable to continue this policy, so as to give all the assistance possible in the search for clays suitable for the various needs. There are instances, however, in which charges for tests must be made, and prices for the work will then be sent on application to the Director.

The physical tests, only, are undertaken by the Ceramic Division. These tests give all the information that clayworkers require to know, regarding the properties and uses of clays and shales.

If a chemical analysis is considered necessary by the individual sending clay samples, it will be made by the Division of Chemistry, the charges being ten to twenty-five dollars, payable in advance.

The following instructions should be observed by those sending clay or shale samples for examination. The exact locality from which the sample was taken should be given. The quantity of clay sent should not be less than one pound, but two to four pounds would be better for a preliminary test. A complete test in which it is desirable to make full sized wares requires at least 200 pounds. The samples sould be sent by parcel post, prepaid express, or prepaid freight, to the Mines Branch, Ceramic Laboratory, Sussex Street, Ottawa.

IV.

NOTES ON THE INDUSTRIAL VALUES OF THE CLAY AND SHALE DEPOSITS IN THE MONCTON MAP AREA, NEW BRUNSWICK.

INTRODUCTION.

The Moncton map covers a rectangular area extending 12·3 miles east and west, and 18·7 miles north and south, including portions of Albert and Westmorland counties, New Brunswick. The area includes the city of Moncton and suburbs—a producing gas and oil field; the gypsum deposits of Hillsborough and Demoiselle creek; and the oil shales of Albert Mines and Baltimore.

Owing to the economic importance of this area, considerable attention was given to its varied resources, so that in the event of any extensive developments, these resources could be correlated and made use of in the ordinary growth of an industrial region. The following report deals with the raw materials suitable for structural purposes within the district. Some of the samples of clays and shales examined were collected by the writer in the field during a few days in 1915. Other samples were collected and submitted by Mr. W. J. Wright and his assistants.

The testing was done in the Ceramic laboratory of the Mines Branch, during the winter of 1915–16.

The general and economic geology, as a whole, is in charge of Mr. W. J. Wright of the Geological Survey. Preliminary statements regarding the area are given by him in the Summary reports of the Geological Survey for 1914 and 1915.

Tests on cement materials and gypsum products are now in progress in the laboratories of the Mines Branch, the results of which will be given in later reports on the Moncton district.

SHALE DEPOSITS.

The accessible rocks underlying the greater part of the area included in the Moncton map sheet belong to the Lower and Middle Carboniferous. The latter is represented by the Millstone Grit series, which, in the northern portion of the sheet, is comprised of alternating beds of hard and soft sandstones, with shales; but in the southern portion of the area contains considerable thickness of conglomerates, in addition to the shales and sandstones. The beds of the Millstone Grit formation are flatlying, or slightly arched in places, so that the same beds are often found outcropping over a considerable area.

The Lower Carboniferous rocks occur principally in the southern part of the sheet. These, include the Albert shales, certain beds of red and grey shale, and conglomerates. The beds of this formation are contorted and faulted, so that it is difficult to trace them continuously for any great distance.

Shales, suitable for use in some branch of the clay working industry, occur in accessible positions at many points within the area. Details regarding location, character, and uses for these deposits, constitute the following portion of this report.

Albert Mines.

A bed of soft red shale, about 30 feet thick, is exposed on the east side of the valley near Albert Mines station on the Salisbury and Albert railway. The base of the shale is about 60 or 80 feet above the railway line. It is underlain by conglomerates, and capped by hard sandstones, which form the highest points of the hills on both sides of the valley at this point.

This shale (No. 353), weathers at the outcrops into a soft, rather sticky clay. Near the lower part of the bed it contains a few layers of greenish nodules, with some greenish bands of sandy texture, otherwise the deposit is of a uniform reddish brown colour.

When ground, and mixed with 18 per cent of water, this shale has good plasticity, and excellent working qualities. It flows in a smooth bar through a die, and needs no lubrication. It stands moderately fast drying, but will crack if forced at too high a temperature in the drier.

This shale burns to a good hard body of fine red colour, at cone 010, becoming darker in colour, and steel hard, at cone 06. If burned to a much higher temperature, the shrinkage becomes excessive, and bad effects from overfiring ensue.

Dry press test pieces made from this shale, show that it is admirably adapted for making face brick of a bright red colour, and a dense body with low absorption.

The greenish, sandy bands included in the shale are not an impurity, as they proved, when tested alone, to be very similar to the red shale. The greenish coloured nodules, however, are a decided impurity, as they burn to quicklime, and would destroy any pieces of clay ware in which fragments of these nodules were included.

It would be comparatively easy to discard the layers of nodules when working this shale.

This shale could be used in the manufacture of wire cut building brick, hollow-ware, or fireproofing, roofing tile, field drain tile, and dry pressed face brick.

The material is accessible for mining along the side slopes of the valley in the vicinity of Albert Mines station. The overlying sandstone is eroded in most places, exposing a considerable amount of shale; so that a brick and tile plant situated in the valley bottom near the railway could receive its supply of raw material by gravity.

This shale deposit is widely distributed, and can be traced continuously southward from the outcrops along the hillsides in the vicinity of Albert mines

down the east side of Demoiselle creek, and is found near the level of the railway at McHenry station. The same shale is found exposed at Big Cape on the bank of the Petitcodiac river, and also on the west side of the same river, north of Stony creek.

Soft, red shale, of the Lower Carboniferous, comes to the surface a short distance north of Albert Mines station. In an old working, known as the Alexandra shaft, these shales—when being prospected for the oil shale—were penetrated for a depth of 300 feet. An average sample was taken for testing from the dump at the old shaft.

This shale—No. 354, was not quite so plastic as 353, but its working qualities were good. It was found to stand fast drying without cracking, and its shrinkage was low. It burns to a red colour, and hard dense body, at low temperatures, and could be used for either wire cut or dry pressed bricks. This shale contains a higher percentage of lime than does No. 353, so that the red colour obtained in burning is not so good as the latter. It also contains a certain amount of water soluble salt which will cause an objectionable whitish scum on the burned ware.

Red shales from the same horizon as those at the Alexandra shaft, occur, conveniently situated, at the point where the road from Albert mines to Isaiah Corners crosses Weldon brook. This material (No. 361a) is gritty, so that when it is ground, and worked up with water, does not form a very plastic mass, but it probably would be worked in a stiff mud machine for common wire cut brick. Its drying qualities are good, and the shrinkages are low. This shale burns to a light red colour, with a hard body at the lower temperatures, but turns to buff colour if burned to cone 03. The change in colour to buff, at high temperatures, appears to be due to a high lime content, as the material does not stand over-firing, and will melt at cone 3.

A similar deposit of shale occurs farther north on Weldon Brook, at the road crossing about three quarters of a mile south of Salem station, where it is exposed in a steep bank 10 to 20 feet high. This shale—No. 361, was found to be very gritty, and did not develop any plasticity when finely ground, and tempered with water. It was consequently useless for wet moulded processes of clay working, but worked well when made up by the dry pressed process.

While the body of the dry pressed bricks were hard and dense, the colours were not very good.

A section showing a considerable thickness of dark grey shales, occurs on Frederick brook just east of the Albert shaft. These shales which are quite plastic and smooth, are interbedded with bands of micaceous sandstone. A sample, consisting of equal parts of shale and sandstone, was collected for testing.

This mixture—No. 355, when ground, and worked up with necessary quantity of water, formed a fairly plastic, but rather gritty, wet body. The material dries quickly, and has a low air shrinkage. It burns to a light red porous body, without any fire shrinkage.

If the shale alone is used, the plasticity will be much better than the mixture, the shrinkages greater, the body denser, and the colour darker.

Pressed brick, common brick, or hollow ware of average quality, could be made from this material; but it is not suitable for the manufacture of vitrified ware.

The shale and sandstone beds are almost vertical in altitude along Frederick brook, and are covered by a varying thickness of boulder clay, which is somewhat too thick, in places, for economic removal, especially as the shales do not possess any outstanding quality which would fit them for use in the higher grades of clay wares.

Most of the so-called barren shales which are found in the vicinity of the oil bearing shales, are liable to contain enough carbonaceous matter to render them

unfit for use in the manufacture of clay wares. One or two samples of this kind were tested, and found to be useless. Their behaviour in the raw state, as regards working and drying qualities, was excellent, but they could not be burned safely under any practical conditions.

A bed of yellowish-grey clay underlies the swampy land alongside the railway at Albert Mines station. It is from one to two feet thick, and is underlain by sand. Clay layers may be found below the sand, but this could not be determined without boring, on account of the water. Owing to its high plasticity and smoothness when wet, this clay has attracted a certain amount of attention, and a sample was collected for testing.

The material No. 356, is highly plastic, but rather pasty and stiff in working. It dries very slowly, with a high shrinkage. A steel hard, red coloured body, is obtained in burning to low temperatures. The clay bloats and cracks if burned to a higher temperature than cone 06. This deposit does not appear to be of economic importance, as its extent is small, and its location poor. Aside from its high plasticity, it possesses no important qualities. It was used in a mixture with spent oil shale during the laboratory investigations, the results of this mixture being given elsewhere.

Belliveau, Westmorland County.

The red shale beds of the Lower Carboniferous form the East bank of the Petitcodiac river, at a distance of about 1,000 feet north of the wharf at Belliveau river. The red shale extends northward in a steep bank 10 to 30 feet high, for about 2,000 feet, and is succeeded by a bank of grey shale.

The red shale, No. 358, from this locality, is very gritty, and when finely ground and mixed with water, does not develop much plasticity, so that it is hard to mould.

It dries rapidly with a low shrinkage, and burns to a light red porous body at low temperatures, but develops a buff colour when burned to cone 03.

The grey shale, No. 359, is similar in character to the red variety, but evidently contains a higher percentage of lime, as it develops the buff colour when burned to cone 06. The burned body is exceedingly porous, which is characteristic of clays and shales with a high lime content.

Owing to the lack of plasticity in these shales, it would be difficult to work them by any of the wet moulded processes. The red shale produces a good hard dry pressed brick when burned to cone 03, but the colour is poor. The grey shale, when dry pressed and burned, makes bricks that are too weak and porous to be of any structural value.

Stony Creek.

Near the road running west from the mouth of Stony creek, some red and grey shale beds, not more than 4 feet thick, occur underlying sandstones of the Millstone Grit series.

No. 362, is a greenish-grey, non-calcareous shale of sandy texture, which developed good plasticity and working qualities when ground and tempered with water.

It dried quickly, and had low shrinkages in drying. It burns to a light-red, dense body, at low temperatures, and becomes darker in colour and harder when burned to cone 03.

The red bed, No. 363, overlies the greenish shale, and has similar qualities both in the raw and burned state, but it produces a better red colour, and rather denser body. A very fine, dry pressed brick, with low absorption, and deep

red colour, can be made from it. These shales would be suitable for the manufacture of hollow-ware, or roofing tile; they would give a good smooth finish to any wares made with a die.

Their thickness, however, is not great enough, and the fact that they are mostly overlain by sandstones, places them at a disadvantage for the clay working industry. They were sampled in the hope that they might be suitable for the manufacture of sewer pipe or paving brick, but the results of the tests are not promising for this purpose.

Red shale beds included in the Millstone Grit series outcrop about 2½ miles north of Stony creek, on the road between Moncton and Hillsborough. This shale is very plastic and smooth, with good working and drying qualities. It burns to a strong red colour and dense body at low temperature, and is suitable for the manufacture of wire cut and dry pressed brick, and fireproofing. Its number in the summary table of physical tests is 365.

Shale beds of the same character as 365, are found outcropping on the east side of the Petitcodiac river, in the vicinity of Upper Dover.

Moncton and Vicinity.

Shale deposits.

The Millstone Grit formation underlies the vicinity of Moncton, and extends northward to Lutz mountain, about 4 miles distant. It consists of a series of sandstones, in which are included red and grey shale beds of varying thickness. The cover of glacial drift is so general, that only occasional exposures of the bedrock are seen.

On the west bank of the north branch of Hall creek, about 2 miles north of Moncton, red shales and sandstones are found outcropping in the bank. About 6 feet of red shale is found overlying the sandstone, while a varying thickness of glacial drift overlies the shale. The red shale at this point, No. 364, is very plastic and smooth, it works and dries well in the raw state, and burns to a dense, hard, red body. It is very suitable for wire cut or dry pressed brick, also for fireproofing, and hollow ware.

A short distance farther up Hall creek, on the property of Mr. Wilbur, a bed of bluish-grey shale outcrops near the bottom of the bank. This shale is hard, and of sandy texture when fresh, but quickly weathers to a very plastic light grey clay when exposed to weathering. It does not appear to be more than 3 or 4 feet in thickness; but as it was overlain by a heavy overburden of glacial drift, some of which was sliding down the bank, the exact thickness of the deposit was not ascertained. The overburden appears to be too thick for removal, consequently, the deposit is not of economic value. As similar material may be found in more accessible positions in this vicinity, the following particulars of its character are given.

This shale, No. 350, has good plasticity, and would work well in a stiff mud machine for making brick, or hollow-ware. It burns to a light red, dense body at low temperature, and is capable of standing up at a higher temperature than any of the other shales or clays in the area. For this reason it has been suggested as suitable for the manufacture of sewer pipe, if it can be found in sufficient quantity convenient to transportation facilities. The shale appears to contain a small amount of limestone nodules or layers, which would give trouble in underburned wares, but if the shale is ground finely and burned hard this trouble would disappear. The presence of limestone is a defect which would have to be taken into account in the manufacture of structural wares in order to avoid excessive losses.

Sandstones interbedded with shales outcrop at several points on the south bank of the Petitcodiac river opposite Moncton. None of these shale beds

appeared to be of sufficient thickness for economic working. There is no doubt, however, that at some point along the river in this vicinity, workable shale beds would be revealed by prospecting. But a plant located on the south side of the river would lack the advantage of transportation facilities for distributing the finished products.

Surface clay deposits.

The superficial deposits in the vicinity of Moncton consist almost entirely of a reddish-brown boulder clay or till, there being none of the stratified stoneless clay present, such as occurs in other portions of the Province. Occasional patches of clay occur in the till, which, though not entirely free from stone, can be used for the manufacture of common brick; small deposits of this kind are, worked at Lewisville. The clay obtained for brickmaking is from 2 to 8 feet deep, with some boulders and pebbles irregularly distributed throughout, the largest stones, which are generally sandstone blocks, being at the bottom of the pits. If rolls are used for crushing the smaller pebbles and throwing out the larger stones, and ordinary care otherwise taken in the manufacture, a very good grade of common brick can be made from this clay.

A similar patch of clay was observed on the gas supply pipe line, a short distance north of Moncton. A small sample of this clay was tested, and found to have good working and burning qualities, producing an excellent red building brick at the lower temperatures. This clay will not stand overfiring very well, as it shrinks to excess, and will melt if the firing is prolonged at the higher temperatures. A very good quality of field drain tile could also be made from this clay, but more care would be necessary in its preparation for this purpose than would be required for brickmaking.

All lowlying land along the small streams, contains clay and silt, most of which appears to be stoneless. This land is only a little above high tide water level, so that there might be some difficulty in keeping water out of clay pits. The clay from these areas was not tested, but parts of it might be available for the manufacture of common brick or drain tile.

Lutz Mountain.

A large portion of Lutz and Indian mountains, lying to the north of Moncton, are composed of grey slaty shales, interbedded with thick beds of sandstones. The shales and included sandstone beds are mostly tilted at high angles and appear to have undergone a certain amount of metamorphism or alteration. On this account the shale beds wherever exposed, although they crumble quickly, do not weather into clay.

A sample of this shale was collected for testing, but when finely ground and mixed with water it did not develop sufficient plasticity for good moulding. It dries quickly, and has very little shrinkage, as might be expected from its very gritty character. It burns to a porous, light red body, at low temperatures. Dry press test pieces made from this shale burned to a fairly dense body at cone 03, but the colour was not good.

This material is not recommended for the manufacture of clay products.

There is a considerable body of the Lower Carboniferous red shale exposed on the southern slope of Indian mountain. It resembles the red shale, already described, which occurs along Weldon Brook. The deposit at Indian mountain was not sampled, as it is too far from transportation facilities to be of economic value.

OIL SHALES AT ALBERT MINES AMD BALTIMORE.

If an industry should be established in the future for the purpose of distilling the oil bearing shales at this locality, a considerable quantity of spent shale will result as a waste product—after the oil is extracted. As enquiry will probably be made regarding the utilization of this material, a few experiments were made with a view to determining its usefulness as far as the clay working industry was concerned.

A sample of shale, rich in oil, was collected from the deposits at Baltimore. This shale was burned in a gas muffle kiln for a period of 9 hours, the highest temperature recorded being 750 degrees C. The carbonaceous matter appeared to have been all driven off by this treatment.

When the spent shale was ground and tempered with water it was found to be slightly plastic and capable of moulding into shape. The character of the wet body, however, was of such a nature that it would probably not work if used alone, but would require the addition of a more plastic clay or shale. The material burns to a weak porous body of no structural value at cone 06. If burned to a higher temperature it bloats, softens, and deforms.

A mixture was made consisting of 2 parts of ground spent shale, to one of No. 356—a highly plastic red burning clay.

This mixture had good working qualities in the raw state, and could easily be moulded into shape. It burns to a light red, very porous body, at cone 06. If burned to cone 03, the mixture has excessive shrinkage, and shows signs of overfiring with deformation.

The results of these experiments show, that the spent shale, if used alone is of no value in the clay working industry. If it is mixed with a good plastic clay the working qualities in the raw state are improved, but the character of the burned body does not justify any favourable comment regarding its use in the manufacture of clay wares.

It is also probable, however, that in the actual distillation processes, the carbon would not be so thoroughly eliminated from the shales as it was in the above laboratory test, where only a small quantity of shale was burned. Some clay workers are inclined to regard the presence of a small percentage of carbon in clay as an advantage, because it furnishes a fuel supply which materially increases the temperature in the kiln without any cost.

Coal slack is sometimes added to clay in small amounts by brickmakers in order to facilitate burning. The bricks containing coal slack being placed in those portions of the kiln farthest from the effects of heat due to the regular firing, as in the outside and top courses of brick in stove or clamp kilns. There is a considerable difference, however, in the comparatively coarse and scattered grains of coal slack introduced into clay, and in the finely divided and evenly disseminated asphaltic carbon which occurs naturally in some clays like those under discussion. The latter form of carbon is extremely hard to burn completely out of the pores of the clay, and unless the burning is done with the closest attention, and trial pieces drawn at intervals, is more likely to prove a detriment than an assistance in firing a kiln of ware.

CLAYWORKING INDUSTRY.

The raw materials for the manufacture of structural clay products appear to be abundantly distributed over the principal part of the area included in the Moncton map sheet. As shown by the foregoing tests, most of the shale deposits are suitable for the manufacture of common building brick, face brick, hollow blocks, roofing tile, and field drain tile.

The shale beds included in the Millstone Grit series underlying the northern portion of the area appear to be of better quality for clayworking purposes than

those shales included in the Lower Carboniferous series. Although these shales burn red under normal conditions, they are capable of being altered by the fuel or by shutting off the air supply entering the kiln, so that the resulting bricks are given various dark shades of colour, such as bronze, or purple. By this means, special brick for mantels, or face brick for buildings, can be produced with a small additional expense, but which bring a far higher price than the ordinary brick.

Roofing tile and floor tile are also among the possible products from these deposits. Ware of this kind may be shipped for long distances, and is profitable if the manufacture is skilfully done and losses avoided.

Recommendations regarding the manufacture of paving brick from these shales could not be made until some more extensive tests were made upon the material. Small test pieces made from the shales were burned to vitrification without softening or deformation, but the fire shrinkage is rather high.

Samples Nos. 364 and 365, seem to be about the most promising materials for this purpose. The range of vitrification is rather small, but with careful firing it might be possible to make satisfactory vitrified wares.

One serious drawback to the deposits is the fact that, they do not seem to occur in large enough quantity, and in positions best suited for easy working on a large scale. Workable deposits, however, might be revealed by further prospecting.

Natural gas is regarded as one of the best fuels for the burning of clay wares. It produces clean burned wares, is easy to apply, and perfect control of temperature can be secured by its use, so that a plant located in this region near the gas supply would enjoy peculiar advantages.

At present there is not much demand for structural clay products in this region. Wooden construction has hitherto been used almost exclusively throughout the towns and rural districts for dwellings and stores.

There is need for a more permanent class of building and also those which provide more resistance to widespread destruction by fires. Such requirements are most easily and cheaply provided by the numerous varieties of modern structural clay wares.

No agricultural tile is made in New Brunswick, therefore, the inference is, either that the farming community have not yet realized the advantages to be gained by under drainage, or that there are no lands in the Province requiring under drainage.

As there are very few areas of agricultural lands in eastern Canada which would not be benefited by under drainage, it is presumed that there may be sufficient interest aroused in this matter of increased production in New Brunswick, which will result, later on, in a demand for drain tile.

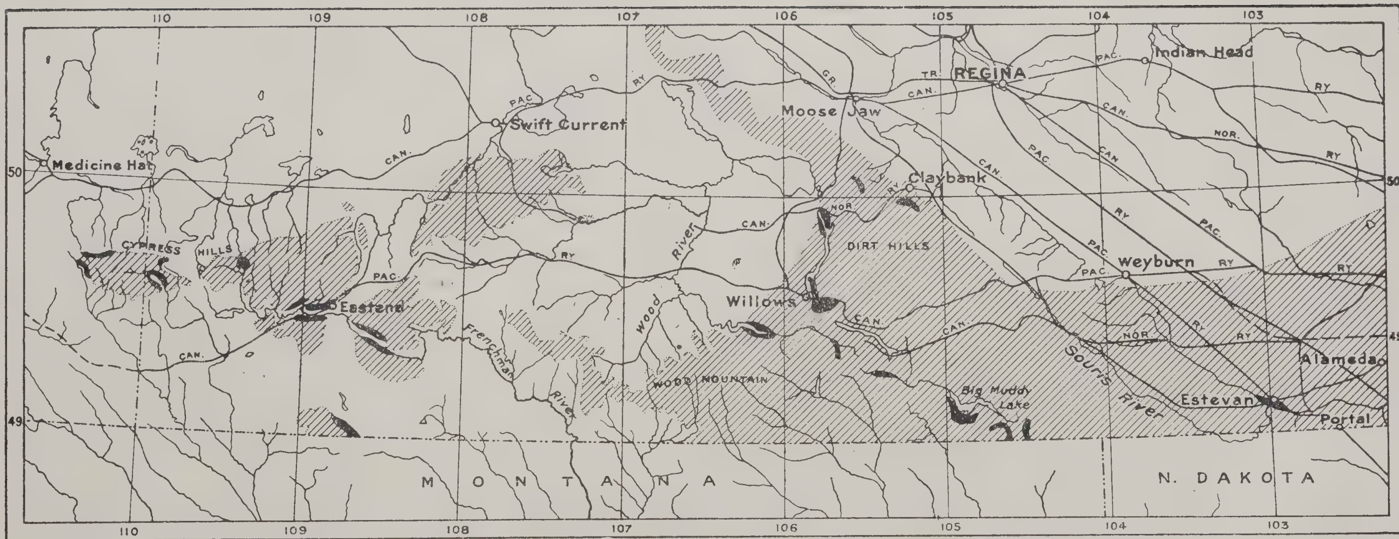
Nearly all the shales described, are suitable for the manufacture of farm tile. These could be profitably made in any brick plant, on the same machinery and equipment, so that tile and brick could be produced alternately, according to the demand there was for either class of ware. It would cost a little more for grinding shale in order to make drain tile, therefore, it might not seem feasible to compete with small plants using surface clays which require little or no preparation before moulding. A superior tile, however, can be made from the shales, which would stand transportation better, without so much breakage as those tiles usually made from surface clays. As far as the surface clays are concerned, those found within the area of the Moncton map sheet, would require to be passed through rolls in order to crush the stones and pebbles, which occur so plentifully, before being made into tile. The stratified surface clays that occur at Fredericton, Bathurst, Campbellton, and other places are free from pebbles, and do not require such treatment; but it is an advantage

Summary Table of Physical Tests.

Lab. No.	Locality.	Drying shrink.	Cone 010.		Cone 06.		Cone 03.		Cone 1.		Cone of fusion.
			Fire shrink.	Absorp.	Fire shrink.	Absorp.	Fire shrink.	Absorp.	Fire shrink.	Absorp.	
350	Wilbur Farm, Hall creek	5	0·7	12	4	11·5	1	10·5	0	5	6
351	Pipe line, north of Moncton	7	1·3	15·5	2	8	8	2	–	–	1
352	Grey shale, Lutz mountain	2·5	0	15	0	–	0	10	–	–	3
353	Red shale, Albert Mines	6	0	12	0·5	9	2	7	–	–	3
354	Alexandra shaft, Albert Mines	5	0	11	0·4	11	0·4	11	–	–	3
355	Frederick brook, Albert Mines	5	0	20	0·4	15	1	14	–	–	2
356	Swamp clay, Albert Mines	9	1	11·5	–	–	3·6	5	–	–	3
358	Red shale, Belliveau	3	0	16	0	16	0	12	–	–	3
359	Grey shale, Belliveau	3	S	24	S	23	0	22	–	–	3
361a	Weldon Brook, near Albert Mines	4	1	14	1	13	2	13	–	–	3
362	Greenish shale, Stony creek	5	0·7	12	1	11	1·7	9	7	0	4
363	Red shale, Stony creek	5	0·6	13	1·4	10	4	7			4
364	Red shale, Moncton	6	1	11	1	8	3	6	4	0	4
365	Red shale, Lower Coverdale	6	0	12	0·3	11	0·6	11	6	0	4

S = swelling.
Approximate temperatures of softening points of cones:—

Cone 010............1742 degrees F., 950 degrees C.
„ 06............1886 „ „ 1030 „ „
„ 03............1994 „ „ 1090 „ „
„ 1............2102 „ „ 1150 „ „
„ 3............2174 „ „ 1190 „ „



Fort Union formation.

Clay outcrops.

Fig. 3. Index map of southern Saskatchewan: showing Union formation, and location of important clay outcrops.

to work almost any variety of clay rather thoroughly for tile making. The clays found in the bottom lands, along the margin of streams, at about high tide level, appear to be stoneless, and if not too silty or short in texture, might be suitable for tile making. The principal difficulty about working these deposits would consist in keeping water out of the clay pits. These clays were not tested, so nothing definite can be said at present about their quality.

V

THE CLAYS OF SOUTHERN SASKATCHEWAN.

N. B. Davis.

In the southern part of the Province of Saskatchewan there is located one of the most valuable and extensive clay fields of the Dominion of Canada. From the vicinity of Estevan, westward along the International Boundary some two hundred and fifty miles, and north to make a triangular area with the apex west of Moose Jaw, the country is underlain by a series of clays, silts, sands and lignites, comprising what is known to geologists as the Fort Union formation. West of this again, smaller detached areas of this same formation outcrop in those elevated areas known as Boundary Plateau, White Mud River Plateau, and the Cypress Hills.

Although the Fort Union formation is known to generally underlie these areas, the valuable clays are not available everywhere over them. It is only in the escarpments of the plateaus, and in the large river valleys, with their tributary coulées, that good workable sections of the clays are to be found.

The most important beds of this formation, to the clayworker, are the white and grey refractory clays and clayey sands, constituting what are locally known as the "white muds." The white plastic clays are of stoneware character, fusing around cone 15. The more sandy beds are quite refractory, some of them standing up to cone 30.

These refractory clays are followed in importance by yellow calcareous clays and clay silts, which are suitable for common clay ware, such as brick and drain tile; and for mixing with the stoneware clays to reduce the temperature of vitrification in making sewer pipe and hollow block.

Dark grey, brown, and black, gumbo-like clays occur in the same formation, but their drying defects are so bad that they cannot be used without special preliminary treatment, such as the preheating practiced at Estevan.

Lignite beds of fair quality are here and there associated with the clays, and their economic aspects are of great importance to the future of the clay-working industry.

The accompanying index map (Fig. 3) shows the general distribution of the clay-bearing Fort Union formation, the important clay outcrops being suitably indicated.

It will be noticed that the largest area includes the elevations known as Wood mountain and the Dirt hills, and in the following note these localities, along with other prominent topographical features, such as the Big Muddy valley, Souris valley, and Cypress hills, will be used as headings.

Cypress Hills.

The section of clays found in the Cypress hills is the most complete one in the Province. The hill tops are protected at the highest elevations by quartzite gravel, the pebbles of which should prove of value for grinding purposes. Below

the gravel there is a great thickness of fine, plastic, greyish white, to mottled red and green clays. They are best exposed near the western end of the hills. Some of these are slightly calcareous. Their working qualities are favourable.

The white refractory clays are not exposed here, but, continuing eastward easily worked outcrops are to be found near old Fort Walsh on Battle creek, and in the valley of the White Mud or Frenchman river, the most important locality being the last named.

From Palisade to South Fork the Canadian Pacific railway follows the deep valley of the Frenchman river and Swift Current Creek coulée. For most of this distance, some fifteen miles, the white clays can be seen, outcropping in the valley sides within a mile or so each side of the railway. (Plate X).

A typical section measured in the vicinity of Ravenscraig resulted somewhat as shown in Plate XI.

It will be noted that the white clays are underlain by a considerable thickness of greyish-white quartz sands, which may prove of value for moulding or glass making.

The yellowish calcareous clays, silts and sands overlying the white clays are quite thick, but erosion has here and there made the white clays available without underground mining operations being necessary.

The beds are all more or less lenticular, all through the Fort Union formation, they thicken and thin from place to place. Along the Frenchman river the good clays appear to increase in thickness eastward, while to the west the beds are more sandy.

In the vicinity of the town of Eastend, where the railway leaves the valley of the Frenchman river, the best workable outcrops are to be found. To the north and south of the town, erosion has bared considerable quantities of the valuable white clays; in one outcrop the following section was measured:—

		ft. ft.
1.	Glacial drift	1 to 10
2.	Brown clay	8
3.	Fine yellow sand	2
4.	Plastic white clay	5
5.	Purplish grey clay	2
6.	White plastic clay	6

The clays below the glacial drift at this point have good working qualities, with shrinkages within practical limits. They burn to dense, greyish bodies at cone 5, and do not soften until the deformation of cone 15. The Albany slip, Bristol, and salt glazes have been applied, with success, to these bodies. (See Plate XII.)

The glacial clay silt of the valley bottom near Eastend burns to a fine deep red colour at cone 010. A small quantity of sand would have to be added to the clay, however, to dry it without cracking. It could then be used for the manufacture of hollow building block and common brick.

Wood Mountain.

Between Eastend vicinity and the northwest slope of Wood mountain the country is heavily covered by glacial deposits, and the Fort Union clays are hidden.

In the coulées tributary to the Wood river and around Twelve Mile lake the white clays again appear. A sample of a sandy, white clay, collected on the north shore of Twelve Mile lake, stood up to cone 28.

Farther northeast, in the Lake-of-the-Rivers valley, near Willows station, on the Canadian Pacific railway, the Alberta Clay Products Company is working

a fine section of the refractory clays, and shipping the run-of-bank some 450 miles, via Weyburn and Moose Jaw, to Medicine Hat. At this place it is worked into sewer pipe, flue lining, wall capping, etc.

The run-of-bank burns to a dense body at cone 9. A sample of a fifteen foot bed in this section reflects the properties of a ball clay.

Dirt Hills.

The white clays appear farther north again in the Lake-of-the-Rivers valley, near Mitchellton on the Canadian Northern railway, and again along the north-facing escarpment of the Dirt hills. It is here at a place called Claybank that the Saskatchewan Clay Products Company is operating the only plant in Saskatchewan using the refractory white clays. (Plate XIII.)

The plant consists of the usual pit equipment of cars hauled by cable, a large storage shed, one dry pan, one dry press machine, and eight round down-draft kilns. Power is supplied by a 150 H. P. Diesel oil engine.

The white, greyish-white and sandy clays are blended to make dry press face brick of plain buff and flashed colours.

Mr. George Shoemaker is manager of the plant, and at present is carrying on experimental work with the intention of placing fire-brick on the market, tests on some of the clays having shown them to stand up to cone 30.

Big Muddy Valley.

In the Big Muddy valley, from Willowbunch lake, southeast to the International Boundary, the white clays outcrop here and there all down the valley. The best exposures are located near the boundary line in the vicinity of Big Muddy post office. Tests on a number of samples from this locality show the clays to be in all respects similar to those found in the other areas described.

Souris Valley.

East of the Big Muddy valley, the white clays are not known to outcrop. The whole thickness of the Fort Union beds consists of dark grey, brown and yellow clays and numerous lignite seams. The best outcrops occur in the Souris valley and more particularly in the vicinity of Estevan, where numerous plants are working the red and buff burning clays for making common and face brick, and hollow block. The red burning clay has to be preheated to overcome checking and is then made into dry press bricks.

The industry is fairly well established in the Estevan field, there being some three plants equipped for operation at the present time.

Railways and Fuel Supply.

Until but recently rail transportation has been lacking to the most valuable clay areas. The Portal-Moose Jaw branch of the Canadian Pacificr railway has served the Estevan field for a number of years, but the important refractory clays do not occur there.

Just two years ago the Canadian Northern railway completed its Avonlea-Gravelbourg branch as far as Claybank in the Dirt hills, and made the high grade clays of this locality available. However, the market for high class face brick broke about the time the railway arrived, and the plant at Claybank suffered accordingly. During the past year the same Canadian Northern railway branch has been constructed farther west, and made available the clays of the north end of Lake-of-the-Rivers, near Mitchellton.

Three years ago the Canadian Pacific railway started its Weyburn-Lethbridge line, and since then has tapped the clays of the south end of Lake-of-the-

Rivers and of the White Mud river valley. The line is now completed as far west as the Alberta boundary, and it is hoped that the time will not be far distant when connexion will be made with the construction east from Lethbridge.

South of the Canadian Pacific railway the Canadian Northern railway has a branch line extending westward to near the southeast end of Willowbunch lake. If this line is completed along the proposed route, it will open up the clay and lignite areas immediately to the north of Wood mountain.

At present most of the fuel is brought in by rail over the Canadian Pacific railway from Alberta. It is mostly a semi-bituminous coal, and, because of the long haul, the price is high. In the Estevan field a certain amount of the local lignite is utilized, but its full efficiency is not being realised.

Extensive tests, carried on at the fuel testing plant of the Department of Mines in Ottawa, have shown the lignites to be ideal for making producer gas for power generation in a gas engine. No steaming tests have been made, but the analyses point to its successful application in this way under suitable mechanical conditions.

The gas producer has come to the clay-working industry to stay, and the clay-workers of Saskatchewan, and the West generally, should not be slow to adopt it as an economical means of converting a poor fuel to a high grade one.

Natural gas has not been struck, as yet, in commercial quantities anywhere in the southern part of the Province. Preparations are being made to sink a well at Eastend in the hope of getting a cheap fuel to aid in the local development of the clays.

The Future of the Clay Industry.

The importance of the clays of Southern Saskatchewan to the whole Canadian west cannot be overestimated. There is an abundance of high grade clays suitable for the manufacture of refractories, of stoneware, Rockingham ware, and white earthenware, as well as for all varieties of burned clay products for structural purposes.

Before the outbreak of the war in Europe, the immediate future of the clay industry in Saskatchewan promised well. The railways were spreading lines of transportation over the country, crops were fair, and the western farmer was beginning to appreciate something better than a sod shack to live in. Lumber had to be hauled great distances and the price was accordingly high. Prairie fires were teaching the builders with wood the value of more fireproof construction. Altogether, the country was ripe for a better supply of burned clay products.

With the war on needs have not materially changed. Business is simply marking time for a better monetary condition. The country is essentially a farming one, and with wild boom days over, and the war at an end, normal conditions should soon return.

DIVISION OF CHEMISTRY.

THE CHEMICAL LABORATORY—SUSSEX ST.

F. G. Wait,

Chief of Division.

The laboratory has been in operation, without interruption throughout the year, and the usual wide variety of work has been accomplished.

Mr. M. F. Connor has been engaged solely in rock analysis.

Mr. H. A. Leverin, in addition to making the furnace assays referred to below, has been engaged in work which was for the most part of a technical character.

Mr. N. L. Turner during a portion of the year has made several rock and mineral analyses and for the remainder of the time has been engaged in work of a purely technical character.

Mr. R. T. Elworthy's time has been fully occupied in the analysis of mineral waters.

All have devoted themselves to the tasks alloted them with commendable assiduity.

The work done during the year is susceptible of the following classification:—

ASSAYS.

Gold, Silver, and Platinum:

Assays for gold, silver and platinum—80 samples.

These were distributed as follows:

(1) *New Brunswick*, 2 samples.

Both from McWhinney farm near Fairfield, St. John county.

(2) *Quebec*, 16 samples.

Pontiac county—

Eardley township, lot 22, range XI, 2 samples.
Eardley township, Eardley mountain.
Mansfield township. Precise locality not given.
Waltham township—lot 30, range II.
Waltham township—lot 37, range III.

St. John county—northwest side of Lake St. John.

Timiskaming county—9 samples.

Figuery township—Tremblay claim, 3 miles N.E. of Amos, P. O.
Dubuisson and Varsan townships—Sullivan claim east side of De Montigny lake.
Dubuisson and Varsan townships—Le Blanc claim, south side De Montigny lake.
Dubuisson and Varsan townships—Benard claim, east side De Montigny lake.
Dubuisson township—extension of Le Blanc claim, on Harricana river.
Guyenne township—Chikobi mountain, north side.
Guyenne township—Chikobi lake—south shore, near east end.
Guyenne township—Chikobi lake—main peninsula.
Upper end of the 66 chain portage, left bank, Harricana river.

(3) *Ontario*, 17 samples.
Prescott county—Alfred township, lot 26, con. I.
Nipissing district—Cassels township—N.W. side of White Bear lake.
Addington county—Sheffield township, lot 5, con. XIV.
Timiskaming district—Langmuir township—3 samples.
Nipissing district—Calvin township, lot 28, con. IX, No. 1 shaft.
Nipissing district—Munro township, 11 miles east of Matheson.
Nipissing district—Munro township, 20 miles east of Porcupine gold field.
Timiskaming district—Maisonville township—Desmarais claim—6 samples.
Nipissing district—Calvin township, lot 28, con. IX.
Calvin township, lot 31, con. IX.

(4) *Manitoba*—2 samples—both from the vicinity of Flinflon lake.

(5) *Saskatchewan*—
Beaver lake, east side.
Beaver lake—claim No. 15, lying N. W. of Beaver lake, 2 samples.
Magdalen lake—from a quartz lode running through Bonnie Doon, Killarney and By town claims lying north and west of the lake.
Magdalen lake—from a similar lode traversing Hartley, Elgan and Donalda claims. South and west of the lake.
Wolverine L.—from a like lode running through claims Orlando, Orlop, and Opex, lying south and west of Wolverine lake, and at the same time north of Beaver lake.
Phantom lake—vicinity of.

(6) *Alberta*—6 samples.
Black sand from the South Saskatchewan river at or near Medicine Hat.
Lake Athabaska—Fond du Lac.
Lake Athabaska—Black bay.
Lake Athabaska—Lake Point claim, near the 'Narrows'.
Lake Athabaska—Island claim, on an island at the 'Narrows.'
Lake Athabaska—Paris claim, 10 miles east of Fond du Lac.

(7) *British Columbia*—
Black sand from Hootalinqua river.
Cariboo district—from the property of the Horsefly Hydraulic Syndicate.
Ymir mining camp—6 samples.
New Westminster district—from a point in unsurveyed territory 5 miles east of Rosedale and 1 mile south of the Canadian Northern railway.
Skeena mining division—from the Kildare Mining Company's property.
Lillooet and Ashcroft mining divisions as follows:
a. oxidized gold ore from Cadwallader.
b. Balloney type of ore from Jewess property.
c. Arrastra tailings from Lorne mine.
d. Copper bearing ore from Glossy mine, Highland valley.
e. From Boulder creek.
?. Mining division:—indefinitely defined mountainous country lying between the Nisutlin, Pelly and Liard rivers about three days' journey from Hoole canyon. 4 samples.

(8) *Yukon Territory*—1 sample taken from near the head waters of Rude creek.
Undefined localities—18 specimens.

Copper Ores.

Three specimens of cupriferous ores, all from undefined localities in New Brunswick, have been disposed of.

Clay and clay shale.

One sample of ferruginous clay from McWhinney farm near Fairfield; and one of clay shale from near Mispic river, both from St. John county, New Brunswick, have been submitted to partial analysis.

Glass sand.

One sample of sand which it was thought might be advantageously employed in the manufacture of glass, has been analyzed and found to compare very favourably with similar material from Belgian sources. The sample examined was collected near Rockwood, Ontario.

Identification of samples.

Considerably over one hundred samples of rock sand minerals have been sent us either for identification or for an opinion as to their commercial value None of these involved any chemical analysis and in most cases were found to be unimportant. We were not informed of the source or origin or locality of ninety-two of the one hundred and three so submitted.

Iron ores. 23 samples.

Of these 17 magnesites were from the undermentioned localities in Ontario.

1. Thunder Bay district—Locations W. 216, W. 218, W. 219 of the Matawan range.
Thunder Bay district—Location 1937 T. B. south of Lower Shebandowan lake.
Thunder Bay district—Location 530 East of Greenwater lake.

1. *Thunder Bay district:*—
(a) Matawin range—locations 216, 218, and 219—6 samples.
(b) Matawin range—locations unspecified—2 samples.
(c) Atikokan iron range—locations R. 400, and R. 401—2 samples.
(d) Atikokan iron range—unspecified locations—3 samples.
(e) Atikokan iron range—mile post 140 C. N. Ry.
(f) South of Lower Shebandowan lake, location 1937 T. B.
(g) East of Greenwater lake—location 530.

2. *Little Pine lake*—north of Port Arthur.
From British Columbia 5 samples of limonite were received from the property of the North Pacific Iron Mines Ltd., on Limonite creek, Skeena river, and
1 magnetite from the Iron King claim situated at the head of Nelson creek, some 12 miles from Ashcroft.

A single sample from an unspecified locality in Nova Scotia was also examined

Infusorial Earth. 4 samples.

There has been renewed considerable activity for this commodity during the year and four samples have been sent up for analysis. All are from previously

known localities but we are in possession of some additional information regarding the quantities available in each.

The four samples analyzed were from the undermentioned localities.

Nova Scotia—Colchester county—at Silica lake, Victoria county—at St. Anne's bay.
New Brunswick—St. John county—Fitzgerald lake.
Quebec—Montcalm county—lot 15 of Chertsey township.

Dolomites and Magnesites.

Quebec.

The work upon Mr. Frechette's collection of limestones and dolomites from the western part of the province of Quebec commenced in 1914, was continued during 1915 and 78 samples were reported upon.

They were from the localities or quarries designated below:—

1. Arthabaska Co., Warwick tp., 23 r. I.
2. Bagot Co.
   St. Dominique.
   St. Dominique.
   Upton tp., 1. 51 r. XXI.
   Upton tp., 1. 49 r. XX.
   Acton tp., 1. 34 r. V.
   Acton tp., 1. 31 and 32 r. III.

3. Beauharnois Co.
   Valleyfield.
   One mile west of St. Louis de Gonzague.

4. Brome Co.
   Brome tp., 1. 10 r. XI.
   Brome tp., 1. 16 r. XI.
   Bolton tp., 1. 28, r. X.
   Potton tp., 1. 24, r. X.

5. Drummondville Co.
   West Wickham tp., lot 14, r. X.
   Shore of St. Francis river 4 miles east of Drummondville.

6. Frontenac Co.
   Lambton tp., lot 22, r. III.

7. Huntingdon Co.
   2 miles west of Huntingdon.

8. Iberville Co.
   Clarenceville.

9. Jacques Cartier Co.
   Pointe Claire.

10. Laprairie Co.
    Cote St. Marc, lot 6.
    Caughnawaga, Indian quarry

11. Laval county.
    Village Belanger.
    Paquette and Gauthier's quarry, St. Martin.
    Theodule Saumure's quarry, St. Martin.
    Pointe aux Trembles.

12. Missisquoi Co.
    One mile east of Stanbridge station.
    Stanbridge tp., lot 13, r. VI.
    Stanbridge tp., Mystic.
    Stanbridge tp., Walbridge quarry, lot 15, r. VII.
    Stanbridge tp., lot 21, r. VI.
    Stanbridge tp., lot 2, r. VII.
    Stanbridge tp., lot 7, r. VI.
    Stanbridge tp., lot 6, r. VII.
    Stanbridge tp., lot 2, r. IX.
    West Parish of St. Armand, lot 13.
    Parish of St. Armand, Phillipsburg.

13. Montreal.
    St. Denis quarry.
    Jorie property.

14. Napierville Co.
    One mile south west of Napierville.
    St. Cyprien de Napierville.

15. Richmond Co.
    Stoke tp., lot 13, r. VII.
    Shipton tp., lot 18, r. 1.

16. Rouville Co.
    Mount St. Hilaire.
    Casimer road.
    Casimer road.

17. Shefford Co.
    South Stukely, lot 8, r. II.
    North Stukely tp., lot 13, r. VII.

18. Sherbrooke Co.
    Ascot tp., lot 7, r. V.

19. Stanstead Co.,
    Magog tp., lot 12, r. XIV.
    Stanstead tp., lot 27, r. II.
    Stanstead tp., lot 20, r. I.
    Hatley tp., lot 6, r. IV.
    Barnston tp., lot 5, r. V.

20. St. John's Co.
    David Brault's quarry near St. Johns.
    Grande Ligne.
    St. Bernard South.
    Legeault's quarry, III Line.

21. Wolfe Co.
    - Weedon tp., lot 8, r. V.
    - Dudswell tp., lot 21, r. VII.
    - Dominion Lime Co., Limeridge.
    - Dominion Lime Co., Limeridge.
    - Dudswell tp., lot 15, r. V.
    - Weedon tp., lot 17, r. III.
    - Weedon tp., lot 21, r. VII.
    - Stratford tp., lot 22, r. V S. W.
    - Weedon tp., lot 26, r. VII.
    - Garthby tp., lot 3, r. "C".

In addition to the foregoing the following samples from this province have been examined:—

Argenteuil Co.—Calcareous magnesites and dolomites from:

I Vicinity of Grenville.
II Grenville tp., lots 11 and 12 of range VIII, 2 samples.
III Buckingham tp., lot 10, range IV.
IV Grenville tp., lot 8, range IV.
V Montcalm tp., 3 M. S. W. of Weir P. O.

Brome Co.—I Bolton tp., lot 17, range IX.

Nova Scotia—1 sample.

A single sample has been submitted from this province. It was taken on Campbell's farm, at Judique, Inverness co.

New Brunswick—4 samples from the following localities, in St. John county.
I Green Head quarry.
II C. H. Peters and Sons' quarry.
III From near Mispic river.

Ontario—2 samples both taken in Algoma district; West shore of Big Lake in township 144, (a) from the Lower and (b) from the Upper, limestone formations of the Bruce series. Geological horizon. Upper Huronian.

Manitoba—11 samples in all.

One from each of the undermentioned localities.
a. Lake Manitoba, South Athapapusko bay.
b. Lake Winnipeg, Big island.
c. Lake Winnipegosis, from the Upper Devonian beds.
d. Lake Winnipegosis, Whiteaves point,—average stone.
e. Stony Mountain, from an 18–inch bed in the city quarry.
f. Broad valley, a sample of Silurian limestone or manitobite.
g. Cedar lake, Silurian limestone from an island in the lake.
h. Point Wilkens, from the lower beds of the Devonian.
i. Silurian limestone from the beds at the grand rapids of the Saskatchewan river.
j. Table lake—south side.
k. Lake Manitoba—South Athapapuskow Bay.

Saskatchewan—

A single sample taken on the east side of Beaver Lake.

Alberta—

5 samples—one from each of the following localities:—

I Fitzhugh, from the Silurian limestone on the property of the Fitzhugh Lime Company.
II Nordegg, from the Devonian limestone.
III Banff, Crystalline Upper Banff limestone.
IV Banff, Triassic limestone at Spray river.
V Exshaw—a selected sample from the Canada Cement Co's property, Lower Banff series.

Marl.

Only one sample of calcareous marl has been submitted. It was taken from the Meath peat bog situated in the townships of Stafford and Westmeath, Renfrew Co.

Nickel ores. 2 samples.

Beyond barely mentioning that two samples of supposedly nickelferous pyrrhotites have been examined, nothing further can be said, as no particulars of the locality of occurrence were furnished with either specimen.

Sandstones.

Intended for employment in building operations.

19 samples, collected at the undermentioned localities, in Manitoba and Alberta, by Dr. W. A. Parks, in connexion with his investigation of Canadian building stones, have been submitted to analysis with the object of determining their suitability for employment as building material. Partial analyses, showing the nature of the cementing material were made upon one specimen from each of the following localities:—

Winnipeg sandstone, Punk island, Lake Winnipeg.
Boissevain sandstone, John Robertson's quarry, Boissevain.
Paskapoo sandstone, grey beds, Entwistle quarry.
Paskapoo sandstone, blue beds, Entwistle quarry.
Paskapoo sandstone, blue beds, Entwistle quarry.
Dakota sandstone, west branch McLeod river, Alberta.
Edmonton sandstone, mile 156½, C.N.R., Rocky Mountain House line.
Paskapoo sandstone, best soft buff, Oliver's quarry, Calgary.
Paskapoo sandstone, best hard buff, Oliver's quarry, Calgary.
Paskapoo sandstone, hard grey, Oliver's quarry, Calgary.
Paskapoo sandstone, average Glenbow stone.
Paskapoo sandstone, best upper beds, Shelley quarries, Cochrane, Alberta.
Paskapoo or Edmonton sandstone, Monarch quarries, Alta. (blue).
Paskapoo sandstone, Porcupine hills near McLeod, Alta.
Paskapoo sandstone (Edmonton ?), Monarch quarries, Alta. (buff).
Paskapoo or Edmonton sandstone, Maclean's quarry, Monarch.
Paskapoo sandstone, Brocket quarries, Alta.
Hard head, Entwistle quarries, Alta.
Blue hard head, Oliver's quarry, Calgary.

Waters.

The work on the mineral waters of Canada has progressed steadily during 1915, although no further springs than those mentioned in the Summary Report for 1914 have been visited, the chemical analyses of certain of the waters therein listed having taken all the year to complete.

Analyses of the following waters have been carried out:—

Samples from five deep wells owned, one each by:

The Mount Bruno Floral Company, St. Bruno, Chambly co., P. Q.
Messrs. Charles Gurd and Co., Montreal.
Guaranteed Pure Milk Co., Montreal.
Blue Bonnets race course, Montreal.
Watson, Foster Co., Maisonneuve.

and one from each of the following springs:

Radnor Forges mineral spring, Champlain co., P. Q.
Gillans spring, Pakenham, Ont.
Maskinonge spring, Maskinonge co., P.Q.
Sanitaris spring, Arnprior, Ont.
Potton spring, Brome co., P. Q.
St. Severe spring, St. Maurice co., P. Q.
Berthier, Berthier co., P. Q.
St. Genevieve de Batiscan, Champlain co., P. Q.
St. Hyacinthe, St. Hyacinthe co., P. Q.
St. Benoit, county of Two Mountains, P. Q.
Abenakis springs, Yamaska, P. Q.

The analyses show that the waters are mostly saline in character, their chief constituents being chlorides and bicarbonates of sodium, calcium, and magnesium. No specially interesting characteristics have been observed.

An analysis of the water from a spring in Fiddle Creek canyon, Jasper Park, Alberta, was also made.

The results of the determinations of the total radio-activity—namely that due to dissolved radium emanation and to dissolved radium salts—have been tabulated but will not be published until the final report is issued. It can be stated however that the highest results were given by the Sanitaris spring, the Varennes spring, Radnor Forges spring and Potton spring, although none of these show more than traces of actual radium salts.

Even these waters gave rather low results as compared with springs in other parts of the world, though they are about as active as those from the well known Saratoga springs, N. Y.

Measurements of the quantity of actual radium salts present in the waters are still being carried on. Traces of radium have been found in many of the waters examined, but, it must be remembered, that the methods of measurement being exceedingly delicate, figures are obtained which indicate quantities much below the range of economic importance.

A new electroscope designed for testing the radio-activity of rocks and minerals has been set up and we are now in a position to examine any supposedly radio-active substances.

DIVISION OF MINERAL RESOURCES AND STATISTICS.

I

REPORT ON MINERAL RESOURCES AND STATISTICS, 1915.

John McLeish, B.A.,

Chief of Division.

During 1915 the staff of this Division has as usual been occupied with the duties involved in the collection of statistics and information respecting the mining and metallurgical industries of Canada, and the preparation of Annual Reports on mineral production, etc., which duties are defined more specifically under Section 6 (a) of the "Geology and Mines Act, 1907."

The vacancy caused by the death in October of 1914, of Mr. Cosmo Cartwright was not filled until February 16, 1915, when Mr. A. Buisson, B.Sc., was appointed as Asst. Mining Engineer. Mr. L. L. Bolton, M.A., was engaged temporarily during March, and appointed as Asst. Mining Engineer, August 2.

Statistics of production are collected by correspondence and some 3,300 mine, smelter, and quarry operators now furnish the Department with annual reports of their mining and metallurgical output. The method of procedure followed in the collection of statistical information as well as descriptions of other functions and duties of the Division have been detailed in former summary reports.

The period covered by the statistical record is the calendar year. Thus in December of 1914 and January of 1915 schedules were distributed to mining companies throughout Canada requesting returns of production during the calendar year 1914. Many of these enquiries have to be repeated two and three or more times and such are the difficulties and delays in this work that replies were still being received in June. However sufficient information was available toward the middle of February to complete the usual preliminary report which was sent to press during the last week of that month and distributed during the first week of March.

A synopsis of this report was, following the custom of previous years, presented before the annual convention of the Canadian Mining Institute, which met in Toronto, March 3.

In the compilation of the final reports on mineral production Mr. Buisson has compiled the statistics with respect to metals and metallic ores and has contributed particularly to the chapters on the production of gold, copper, lead, nickel, silver, and zinc, etc. He also compiled for printing the list of metal mines and smelters. Mr. Bolton has contributed the chapters on production of coal and coke, abrasives, asbestos, feldspar, fluorspar, graphite, gypsum, magnesite, manganese, mica, natural gas, petroleum and other non-metallics. Mr. Casey has as usual compiled all the statistics of production of non-metalliferous products and structural materials as well as the record of imports of mineral products, and has prepared for publication the various lists of mine and quarry operators with the exception of the metal mines and smelter list.

The following reports and lists were completed during the year and sent to press on the dates indicated:—

Reports:—

Preliminary Report on the Mineral Production of Canada, during the calendar year 1914—Feby. 24.

The Production of Copper, Gold, Lead, Nickel, Silver, Zinc and other metals in Canada, during the calendar year 1914—Sept. 1.

The Production of Coal and Coke in Canada, during the calendar year 1914—September 1.

The Production of Iron and Steel in Canada, during the calendar year 1914—Sept. 1.

The Production of Cement, Lime, Products, Stone and other Structural Materials,—October 8.

Annual Report of the Mineral Production in Canada during the calendar year—October 22.

Lists of Mine and Quarry Operators:

List of Metal Mine and Smelter operators in Canada, May 21.
List of Coal Mine operators in Canada, July 16.
List of Mines in Canada (other than metal mines, coal mines, stone quarries, clay plants, etc.), August 2.
List of Stone Quarry operators in Canada, August 11.
List of Brick Plants and Cement Mills, August 24.
List of Lime Kilns in Canada, August 24.
List of Sand and Gravel Pits, Sept. 17.

The amount of work involved in the preparation of correspondence, the compilation of statistics of production, imports and exports, the preparation and revision of lists of operators, the writing and checking of reports, indexing of mining literature, and of the incorporations of mining companies, the recalculation of the Vancouver assay office records and other routine work of the Division has increased very greatly during the past few years. Much time is taken up in the preparation of information for correspondents and others, respecting the mining industries and mineral resources of the country, an endeavour being made in all cases, so far as the records and reports of the Department will permit it, to furnish enquirers with the information asked, or advise them where it may be obtained.

II

COMMITTEE ON IRON INDUSTRY.

The appointment of the writer as a member of a special committee to investigate the iron mining industry in Canada, in the capacity of secretary, required that he devote a considerable portion of his own time as well as that of a portion of his staff to the work of collecting information respecting iron ore occurrences. In addition to the office work involved, the writer together with the other members of the Committee, Messrs. LeRoy, Mackenzie and Lindeman, spent over six weeks from May 22 to July 7 visiting the principal iron mining and metallurgical centres in Canada. Following the completion of the statistical reports, Mr. Bolton has devoted his entire time to revising and completing that portion of the Committee's report dealing with iron ore occurrences in Canada.

EXPLOSIVES DIVISION.

Joseph G. S. Hudson.

I

MINE ACCIDENT AT SOUTH WELLINGTON, B.C.

On the morning of February 9, 1915, the newspapers reported that the accumulated water standing in the abandoned Southfield mine, B.C., had been broken into by the north level of the South Wellington colliery, in the mining district of Nanaimo, British Columbia, with the result that the inrush of water had caused the death of 19 men who were working to the deep of No. 3 north level. On receipt of this disaster, the Director of Mines deemed it advisable to offer my services, in an advisory capacity, to the Mines Department of British Columbia. Word was received from Mr. R. F. Tolmie, Deputy Minister of Mines, that on account of the large body of water which had come into the lower workings of the South Wellington mine, from the abandoned workings of the Southfield mine, it would, in all probability, be several weeks before the mine could be unwatered sufficiently to allow the recovery of any bodies, and the holding of a coroner's inquest. Mr. Tolmie telegraphed that sufficient notice would be sent to the Department of Mines, to enable an official representative to go from Ottawa to Nanaimo, to be present at the inquest.

Before the inquest was held, considerable comment had been made as to the accuracy of the plans, as it was apparent that either the South Wellington or Southfield plans were inaccurate, or, that their relative positions, as indicated on the plans, were not correct.

During the month of May, some of the bodies had been recovered from the mine, and notice was given that the coroner's inquest would be held at Nanaimo, on May 17, 1915.

I accordingly left Ottawa on the 11th of May, under the following instructions:—

Ottawa, May 11, 1915.

Dear Sir,—

You are instructed to proceed to Nanaimo, British Columbia, to attend the inquest and investigation relative to the mine disaster at South Wellington, which occurred on February 9, 1915.

You are to take notes of the evidence given, and to render any assistance, in an advisory capacity, which you consider necessary, and in the interests of the Department of Mines.

Yours truly,
(signed) EUGENE HAANEL,
Director of Mines.

To Joseph G. S. Hudson, Esq.,
Mines Branch,
Ottawa.

On my arrival at Nanaimo, I attended the inquest, and was informed by Mr. Graham, Chief Inspector of Mines, that there was almost a certainty that one of the plans was drawn to a scale of 100 feet to the inch, while the old Southfield plan was plotted on two chains, or 132 feet to the inch, but that the Minister of Mines had ordered a check survey to be made, whenever the state of the underground workings would permit; and that an investigation under the "Public Enquiries Act" was to be instituted after the coroner's inquest, and after the surveyor appointed by the Provincial Department of Mines, had finished his survey and plans.

It was brought out in evidence that the plans had been plotted on two different scales; whereas the mine plans showed 415 feet of solid coal when the workings were plotted and compiled on the same scale the barrier of coal was reduced to a few feet, and eventually was pierced through.

After the coroner's inquest was ended and the verdict of the jury returned, notification was given, that under the Public Enquiries Act, Mr. Justice Murphy had been appointed a Commissioner to hold a Court of Enquiry into the cause of the death of the nineteen men who had lost their lives at South Wellington, on the 9th of February, 1915, and that the investigation would open in Nanaimo, and embrace:

(a) The cause of and responsibility for the accident that occurred on the 9th day of February, 1915, in the No. 1 slope of the South Wellington coal mine, resulting in the loss of 19 lives.

(b) The plan and workings of the said mine, and the abandoned Southfield mine adjoining, and generally, the conditions existing in the said mines on the date of the accident.

The investigation was held at Nanaimo, B.C., on the 5th, 6th, and 7th days of July, A.D., 1915. This investigation has resulted in the following legislative additions to the Coal Mines Regulation Act of British Columbia: namely,

(1) Providing for the qualification of mine surveyors.

(2) Providing for barrier pillars in all boundaries.

(3) Re-arranging Section 70, of the present Coal Mines Regulation Act, relative to plans of abandoned mines filed with the Minister of Mines, which read, originally, as follows:

> But no person, except an inspector under this Act, shall be entitled, without the consent of the owners of the mine, to see such plan when so sent until after a lapse of ten years from the time of such abandonment.

The above section has been eliminated, and the following substituted:

> Any owner or lessee operating a mine or property adjoining the abandoned mine, and the inspector in charge of the district in which the abandoned mine is situated, shall on application to the Minister, be furnished with a copy of the abandoned mine so deposited.

II

EXPLOSION AT THE RESERVE MINE, WESTERN FUEL COMPANY, NANAIMO, BRITISH COLUMBIA.

While at Nanaimo, awaiting the opening of the investigation by Mr. Justice Murphy, under the "Public Enquiries Act," into the disaster at the South Wellington mine, an explosion occurred on Thursday, May 27, 1915, in the underground workings of the Reserve mine, B.C.

When news of the accident was brought into Nanaimo, I took the first opportunity of going out to the mine, and placing my services at the disposal of the Inspector of Mines.

At the time of the explosion, which occurred at 4 p.m., there were 36 men underground, of whom 22 lost their lives; 14 making their escape, mainly through the fact that they were in other sections of the mine which were not so directly affected by either the force of the explosion, or the noxious gases resulting from the explosion itself.

The Reserve mine is situated about 4½ miles in a southeasterly direction from Nanaimo, and is connected by a line of railway, owned by the Western Fuel Company, and connecting with their shipping piers in Nanaimo harbour. The seam worked is locally known as the Douglas, which is penetrated by two

vertical shafts: namely, Nos. 1 and 2. Each shaft is 10 feet wide by 26⅓ feet long, inside of the cribbing which is of Douglas fir 10 × 12 inches, and divided into three compartments. No. 1 shaft has a vertical depth of 1,068 feet; and No. 2 shaft, 982 feet.

When the coal was reached by these two shafts, it was found that the seam of coal was much disturbed by faults. The shaft bottoms are located in stone, above the coal seam, No. 1 shaft being 953·3, and No. 2 shaft 948·5 feet from the surface. The two shafts are separated by 350 feet of strata. The surface arrangements at the Reserve mine are modern, and the whole lay-out shows the best practice for safety and economical handling of coal. The machinery is of first class workmanship; and special attention has been given to the ventilating fan.

The mine is ventilated by a double inlet fan, of the "Sirocco" type, 90 inches outside diameter, by 72 inches wide, and capable of producing 200,000 cubic feet of air per minute, with a 4-inch water gauge.

The general character of the "Douglas" seam is gaseous, and it was only reasonable to expect that this large area of virgin coal, penetrated by two deep shafts, would develop a considerable volume of gas.

On account of the very disturbed nature of the ground, due to faulting and the overturning of the strata, outbursts of inflammable gas have been frequent, and in one particular instance, so great was the quantity liberated, that the whole extent of the workings were completely filled, even up to the shaft.

During, or preceding, these outbursts of gas, large quantities of very fine and dusty coal were thrown out. This, in itself, added a great danger to the working of the mine, and every available precaution had to be taken.

From the inauguration of the work of developing the mine, safety lamps have been in use; and there was evidence on every hand that, not only the men having the daily supervision of the mine, but the general management—including mechanical engineering—had spared no trouble or expense to make this new colliery complete and safe for the employees; a most important essential in the successful operation of a mine.

The staff of officials were experienced, practical men, who had spent their whole lives in the winning of coal. Moreover, the underground workings were of such a limited extent that the officials could make a daily examination of the mine, well within the hours specified by the Mines Regulation Act. There was not even a suggestion that the supervising staff had performed their duties in an unsatisfactory manner.

After the ventilation current had been sufficiently restored, the search for the bodies of the missing men was proceeded with, and the position of the bodies noted, and all incidents recorded, so that the fullest inquiry might be made, and the evidence produced at the coroner's inquest. I accompanied Mr. Graham, his staff, officials of the mine, and representatives of the workmen, in this search. The underground workings of this mine were operated under what is known in British Columbia as "Systematic Timbering." The regulation governing the timbering construction is as follows:—

> The manager of the mine shall cause to be posted at a conspicuous place near the mouth of the mine, a notice, stating the minimum size of the different types of timber to be used in such mine, and the maximum distance between the timbers, and between the timbers and face and sides of the working place.

This rule was of the utmost importance, and showed the great value of its adoption, since, after the force of the explosion had spent itself at the shafts, there were comparatively few falls of roof; and the exploration parties had little difficulty in making their investigation.

Mr. James Ashworth, consulting mining engineer, Vancouver, B.C., was appointed by the British Columbia Attorney-General (Honourable W. J. Bowser, K.C.), to make a report on the occurrence of this Reserve mine explosion. This report, together with the report of Mr. Thomas Graham, chief inspector of Mines, has been given in full in the Annual Report of the Minister of Mines, British Columbia, for the year 1915.

I deemed it my duty to offer my services, and in every way be of service to the Department of Mines, and accompanied the officials on all occasions when they were making the investigation commencing on the morning of May 29, and continued every day until June 5, 1915.

The coroner's inquest was opened at Nanaimo on June 16 by Mr. Coroner T. U. Jeffs, of Vancouver, and lasted three days, during which time 33 witnesses were examined. Mr. Graham, chief inspector of mines, British Columbia, requested that I should give evidence, and explain to the jury what in my opinion had taken place and where the initial explosion had taken place. It was rather an unusual request, as I have always considered that the officers of the Mines Branch attended these accidents only in an advisory capacity; but personally, if I am requested to give evidence, I never hesitate to do so, especially if, in the opinion of the jury my evidence would give any information which may be deemed of value in enabling them to arrive at a decision as to the cause of the accident. Not only was every available part of the mine inspected and examined, but a great amount of time was spent in examining the safety lamps which were in use underground at the time of the explosion; also the coal dust collected in various parts of the mine, which was examined under a microscope to determine the amount of coking. This examination was conducted by Mr. Graham, Mr. Ashworth, and the writer.

The plans of the mine showing the underground workings, the ventilation currents, the position of the bodies when recovered, together with other plans necessary to present to the jury, were prepared with great care by the Western Fuel Mine official, who spared no pains in furnishing all information, and giving every facility whereby the direct cause of the accident could be traced.

From personal observation, and after due deliberation, I am of the opinion that the initial point of explosion was in the west level, and in face of counter level. As before mentioned, there had been sudden outbursts of gas in this mine, and after the explosion not much difficulty was experienced in examining the working places, until the counter headings nearest the face of the west level were approached. At this place, from evidence before us, it was manifest that men were in timbering, and that this section was presenting abnormal physical conditions, on account of the extreme pitch and height of the seam. The bodies of the men who were working at this point were the last to be recovered, owing to the fact that there was a large outburst of coal, fallen rock, amounting to 231 tons, and the displacement of 28 sets of timber.

It was evident from the position of the bodies that the coal had fallen upon them suddenly, and with great violence: doubtless caused by a terrific outburst of gas, similar to that noted in a different section of the mine, when, fortunately, the men made their escape.

The body of Thomas Sulter—which was the last recovered—was found nearest to the face of the west counter heading. The glass of the safety lamp on his belt was broken, and the lamp otherwise damaged sufficiently to cause the disaster, if an outburst of gas took place. There was a diversity of opinion as to where the initial point of the explosion occurred, and its cause: Mr. James Ashworth not agreeing with either the Inspector of Mines, the officials of the Coal Company, or the writer.

Mr. Ashworth laid considerable stress on the way the explosives were handled in the mine, and to the effect of a shot fired in the working place next to where, in my opinion, the initial explosion occurred. This brought up the question of permitted explosives, and it is with extreme regret that I have again to record that Canada has not an Explosives Act in force, and that as an official of the Mines Department, I have to acknowledge that Canada is the only well known mining country in which an Explosives Act is not in operation.

The verdict of the Coroner's Jury was as follows:—

We, the jury empanelled to inquire into the death of Robert Kirkbride, William Ball, and twenty others, find that the deceased came to an accidental death by an explosion of gas on May 27, 1915, in the Reserve mine of the Western Fuel Company; and after hearing the evidence of thirty-three witnesses, we cannot attach any blame to anyone. We also find that every care and precaution was exercised by the management of the said company.

DRAUGHTING DIVISION.

H. E. Baine,

Chief of Division.

During the year some 50 maps were compiled and published, besides 400 or more mechanical drawings, charts, flow sheets, etc.

The following is a list of maps published during the calendar year 1914:—

Map No.

232. Mineral map of Canada (second edition).
327. Map showing location of Saline Springs and Salt Areas in the Dominion of Canada.
328. Map showing location of Saline Springs in the Maritime Provinces.
329. Map of the Ontario-Michigan Salt Basin, showing probable limit of productive area.
330. Map showing location of Saline Springs in Northern Manitoba.
340. Magnetometric map of Atikokan Iron-Bearing district, Atikokan mine and vicinity. Claims Nos. 10 E., 11 E., 12 E., 24 E., 25 E., and 26 E., Rainy River district, Ontario.
341. Magnetometric map of Atikokan Iron-Bearing district, Sheet No. 1. Claims Nos. 400 R., 401 R., 402 R., 112 X and 403 R., Rainy River district, Ontario.
342. Magnetometric map of Atikokan Iron-Bearing district, Sheet No. 2. Claims Nos. 403 R., 404 R., 138 X, 139 X and 140 X, Rainy River district, Ontario.
343. Magnetometric map of Atikokan Iron-Bearing district, Mile Post No. 140, Canadian Northern railway, Rainy River district, Ontario.
354. Index map, showing location of Peat Bogs investigated in Ontario.
355. Richmond Peat Bog, Carleton county, Ontario.
356. Luther Peat Bog, Wellington and Dufferin counties, Ontario.
357. Amaranth Peat Bog, Dufferin county, Ontario.
358. Cargill Peat Bog, Bruce county, Ontario.
359. Westover Peat Bog, Wentworth county, Ontario.
360. Marsh Hill Peat Bog, Ontario county, Ontario.
361. Sunderland Peat Bog, Ontario county, Ontario.
362. Manilla Peat Bog, Victoria county, Ontario.
363. Stoco Peat Bog, Hastings county, Ontario.
364. Clareview Peat Bog, Lennox and Addington counties, Ontario.
365. Index map, showing location of Peat Bogs investigated in Quebec.
366. L'Assomption Peat Bog, L'Assomption county, Que.
367. St. Isidore Peat Bog, Laprairie county, Que.
368. Holton Peat Bog, Chateauguay county, Que.
369. Index map, showing location of Peat Bogs investigated in Nova Scotia and Prince Edward Island.
370. Black Marsh Peat Bog, Prince county, Prince Edward Island.
371. Portage Peat Bog, Prince county, Prince Edward Island.
372. Miscouche Peat Bog, Prince county, Prince Edward Island.
373. Muddy Creek Peat Bog, Prince county, Prince Edward Island.
374. The Black Banks Peat Bog, Prince county, Prince Edward Island.
375. Mermaid Peat Bog, Queens county, Prince Edward Island.

376. Caribou Peat Bog, Kings county, Prince Edward Island.
377. Cherryfield Peat Bog, Lunenburg county, Nova Scotia.
378. Tusket Peat Bog, Yarmouth county, Nova Scotia.
379. Makoke Peat Bog, Yarmouth county, Nova Scotia.
380. Heath Peat Bog, Yarmouth county, Nova Scotia.
381. Port Clyde Peat Bog, Shelburne county, Nova Scotia.
382. Latour Peat Bog, Shelburne county, Nova Scotia.
383. Clyde Peat Bog, Shelburne county, Nova Scotia.

REPORT COVERING THE OPERATIONS OF THE DOMINION OF CANADA ASSAY OFFICE, VANCOUVER, B.C., DURING THE YEAR ENDING DECEMBER 31, 1915.

I

REPORT OF MANAGER.

Eugene Haanel, Ph.D.,
Director of Mines Branch,
Ottawa, Ont.

Sir,—

I have the honour to submit herewith Report covering the operations of the Dominion of Canada Assay Office, Vancouver, B.C., for the calendar year ending December 31, 1915, accompanied by statements showing Assayers' and Melters' supplies on hand.

Changes in Staff.

R. D. McLellan appointed Assayers' Assistant, June 21, 1915.
H. E. Warburton appointed Clerk, June 21, 1915.

Summary of Work Done.

There were 1,901 deposits of gold bullion received, melted, assayed and purchased, and before disposing of same the bars weighing under 500 ounces each were assembled and melted into large bars which were also assayed. A total of 2,130 meltings and 2,130 assays were required in connexion with the purchase and disposal of the bullion. All assays were run in quadruplicate.

Two hundred and twenty-two (222) ounces of quartation silver were manufactured and punched into discs ranging in weight from 25 to 750 mgrms.; 22·02 ounces of proof gold and 17,000 cupels were also manufactured and 360 lbs. of slag were treated and values contained in same recovered.

Bullion.

The aggregate weight of the gold bullion deposits before melting was 183,924.49 troy ounces and after melting 179,751.68 troy ounces, showing a loss in melting of 2·2688 per cent. The loss in weight by assaying was 28·56 troy ounces, making the weight of bullion after melting and assaying 179,723.12 troy ounces, the average fineness of same being ·734½ gold and ·194 silver.

The net value of the gold and silver contained in deposits was $2,736,302.31 and was received from the under-mentioned sources:—

Source	Weight			
	Number of deposits	Before melting (Troy ozs.)	After melting (Troy ozs.)	Net value
British Columbia	1,516	96,501·19	93,109·69	$1,311,989.80
Yukon Territory	368	87,040·87	86,284·25	1,418,496.63
Alberta	6	120·08	105·70	1,925.94
Alaska	11	262·35	252·04	3,889.94
	1,901	183,924·49	179,751·68	$2,736,302.31

Credits and Disbursements for the Purchase of Gold Bullion during the Year Ending December 31st, 1915.

Unexpended balance—"Letters of Credit," January 1st, 1915		$44,703.72
Credits established during year ending December 31st, 1915		2,825,000.00
"Letters of Credit" balance written off at close of fiscal year, March 31st, 1915	$19,863.88	
Disbursements for the purchase of bullion	2,736,302.31	
Unexpended balance—"Letters of Credit," December 31st, 1915	113,537.53	
	$2,869,703.72	$2,869,703.72

Disbursements for the Purchase of Gold Bullion and Receipts from Sale of same During the Year Ending December 31st, 1915.

Disbursements for the purchase of bullion on hand January 1st, 1915, bars No.'s 951 to 994 inclusive		$36,918.09
Disbursements for the purchase of bullion during the year ending December 31st, 1915, per cheques Nos. 706 to 956 inclusive, and Nos. 1 to 1124, inclusive (omitting No. 697 cancelled)		2,736,302.31
Proceeds from sale of bullion during year ending December 31st, 1915	$ 2,737,857.80	
Value of bullion on hand December 31st, 1915, bars Nos. 1570 to 1612, inclusive	38,536.33	
Difference in favour of this office		3,173.73
	$ 2,776,394.13	$2,776,394.13

Contingent Account for Year Ending December 31, 1915.

Unexpended balance, January 1st, 1915		$11.74
Funds provided per Official Cheques Nos. 1598, 1780, 1895, 17, 132, 378, 609, 812, 1041, 1223, 1413, and 1587		4,695.00
Amount remitted Receiver-General, per Draft No. 72, at close of fiscal year, March 31st, 1915	$ .97	
Expenditure during year ending December 31st, 1915	4,616.42	
Unexpended balance, December 31st, 1915	89.35	
	$4,706.74	$4,706.74

Contingent Expenditure During Year Ending December 31st, 1915.

Fuel (Gas)	$707.78
Power	255.72
Express charges on bullion	2,240.13
Electric vault protection	300.00
Postage	70.00
Telephones	80.00
Duty, Expressage, Freight, &c., on supplies	48.22
Assayers' and Melters' supplies (purchased locally)	782.73
Sundries	131.84
	$4,616.42

Proceeds from Residues Sold.

Residue sold to United States Assay Office, Seattle, Wash., U.S.A. (Bar No. A–9)	$993.70
48 empty acid bottles sold to B. C. Assay & Chemical Supply Co., Ltd., Vancouver, B.C. (March, 1915)	5.76
	$999.46

Residues on Hand, December 31, 1915.

Recovered from slags, sweepings, old furnaces, old crucibles, etc.—51·01 ounces gold bullion, value	$698.24
42 empty acid bottles	

Miscellaneous Receipts.

Draft No. 0106, in favour of Deputy Minister of Mines (a payment for melting 1·88 ozs. bullion)	$1.00
Draft No. 0117, in favour of Deputy Minister of Mines (a payment for one special assay)	2.00
Draft No. 124, in favour of Deputy Minister of Mines (a payment for treating 2.46 ozs. bullion)	2.00
Draft No. 128, in favour of Deputy Minister of Mines (a payment for treating 163·15 ozs. silver residue)	2.50
Draft No. 136, in favour of Deputy Minister of Mines (a payment for treating 25 lbs. slag)	9.00
	$16.50

The following shows the business done by the Assay Office during the past five years, viz:—

Calendar Year	Number of deposits	Weight (troy ounces)	Net value
1911	442	39,784.70	$647,416.38
1912	527	59,068·83	974,077.14
1913	783	111,479·95	1,448,625.37
1914	1,112	166,148·83	2,029,251.31
1915	1,901	183,924·49	2,736,302.31

I have the honour to be,
Sir,
Your obedient servant,
(*Signed*) **G. Middleton,**
Manager.

II

REPORT OF THE CHIEF ASSAYER.

December 31, 1915.

G. Middleton, Esq.,
Manager,
Dominion of Canada Assay Office,
Vancouver, B. C.

Sir,—

I beg to report the following Assayers' supplies on hand at above date, viz:—

Silver Nitrate Crystals	$\frac{1}{4}$	oz.
Calcic Chloride	$\frac{1}{4}$	lb.
Lead foil, C.P.	75	lbs.
" granulated, C.P.	4	"
Zinc, Mossy, C.P.	2	"
Litharge	$\frac{1}{2}$	lb.
Copper wire	1	spool.
Acid, Nitric, C.P.	3	Winchesters.
" Hydrochloric, C.P.	$\frac{1}{2}$	Winchester.
" Sulphuric, C.P.	$\frac{1}{2}$	"
Ammonia	$\frac{1}{2}$	"
Acid, Oxalic, C.P.	1	lb.
Small Clay Crucibles	92	
Scorifiers, $2\frac{1}{2}$ ins.	6	
" $2\frac{1}{4}$ ins.	17	
Cupels	14,600	
Bone Ash	125	lbs.
Muffles, spare	9	
Muffle furnace linings, spare	1	set.
" supports "	14	
" back stops, "	12	
" plugs, "	10	
Gold Cornets	15·30	ozs.
" Proof	19·86	"
Silver	222·99	"

Your obedient servant,
(*Signed*) **J. B. Farquhar,**
Chief Assayer.

III

REPORT OF CHIEF MELTER.

December 31, 1915.

G. Middleton, Esq.,
Manager,
Dominion of Canada Assay Office,
Vancouver, B. C.

Sir,

I beg to inform you that we have the following supplies on hand in the Melting Department, viz:—

6 top sections of linings and 6 covers for No. 2 furnace.
3 sets of linings, with supports and covers complete, for No. 4½ furnace.
5 " " " " " " " 7 "
6 graphite crucibles, No. 6.
6 " " 10.
35 " " 16.
3 " " 30.
2 " " 40.
30 " " marked o°o
2 graphite crucible covers, No. 6.
5 " " " 14.
6 " " " 30.
6 graphite stirrers.
20 lbs. sodium nitrate.
100 " Carb. soda.
50 " borax.

Your obedient servant
(*Signed*) **D. Robinson,**
Chief Melter.

ACCOUNTANT'S STATEMENT, 1914–15.

The following is a statement of the difference in value of assays between Seattle Assay Office and Dominion of Canada Assay Office between April 1, 1914, and March 31, 1915:—

Paid for bullion at Dominion of Canada Assay Office, Vancouver	$2,105,136.12
Received for bars from United States Assay Office, Seattle.....	2,107,334.40
Difference in favour of Dominion of Canada Assay Office...	$2,198.28

Statement of Deposits of Gold and Earnings.

Deposits of gold..........		$2,107,334.40
Earnings:—		
Crushings and melting 1,352·62 ounces quartz for A. A. Logan	$ 40.00	
Treating 25 pounds slag for John Hopp..........	9.50	
Value of 48 empty acid bottles sold B. C. Assay and Chemical Supply Co..........	5.76	
Value of residue sold United States Assay Office..........	993.70	
	$ 1,048.96	
	$ 2,198.28	
	$ 3,247.24	

The following is a statement of the appropriation, receipts and expenditure of the Dominion of Canada Assay Office for the year ending March 31, 1915, and shows the unexpended balance to be $4,044.12:—

	Appropriation	Expenditure	Unexpended Balance
Maintenance of Assay Office, Vancouver, B.C..........	$20,000.00	$15,955.88	$4,044.12

	Appropriation	Expenditure
Appropriation, 1914–15	$20,000.00	
Receipts per the foregoing statement	1,048.96	
Difference between amounts paid and received for bullion	2,198.28	
Fuel		$625.75
Power and light		244.19
Postage and telegrams		134.17
Telephone		79.90
Express charges		1,780.58
Assayer's supplies		847.17
Printing and stationery		106.10
Premium on bonds		610.45
Contingencies		152.85
Electric burglar alarm service		300.00
Wages:—		
G. Middleton		2,650.00
J. B. Farquhar		1,900.00
A. Kaye		1,800.00
H. Freeman		1,500.00
D. Robinson		1,575.00
R. Allison		1,056.96
G. N. Ford		1,500.00
T. B. Younger		1,200.00
E. A. Pritchett		702.50
H. E. Warburton		255.00
A. D. McLellan		182.50
Balance unexpended		4,044.12
	$23,247.24	$23,247.24

ACCOUNTANT'S STATEMENT, 1915–16.

Assay Office.

The following is a statement of the difference in value of assays between Seattle Assay Office and Dominion of Canada Assay Office, between 1st April, 1915, and 31st March, 1916.

Paid for bullion at Dominion of Canada Assay Office, Vancouver	$2,789,350.71
Received for gold bars from United States Assay Office, Seattle	2,792,670.46
Difference in favor of Dominion of Canada Assay Office	3,319.75

Statement of Deposits of Gold and Earnings.

Deposits of gold	$2,792,670.46
Earnings:—	
Melting 1·88 ozs. bullion for M. F. Keeley	1·00
Special assay for A. J. Brennan	2.00
Treating 2·46 ozs. bullion for M. F. Keeley	2.00
Treating 163·15 ozs. silver residue for G. S. Eldridge	2.50
Treating 25 lbs. slag for John Hopp	9.00
Value of 50 empty acid bottles sold B. C. Assay and Chemical Supply Co., Ltd.	6.00
Value of residue sold United States Assay Office	832.18
	$854.68
Difference between amounts paid and received for bullion	3,319.75
	$4,174.43

The following is a statement of the Appropriation, Receipts and Expenditure of the Dominion of Canada Assay Office for the year ending 31st March, 1916, and shows the unexpended balance to be $3,023.37.

	Appropriation	Expenditure
Appropriation, 1915–16	$20,000.00	
Receipts per the foregoing statement	854.68	
Difference between amounts paid and received for bullion	3,319.75	
Fuel		715.30
Power and Light		257.20
Postage and Telegrams		197.54
Telephone		80.00
Express charges		2,304.93
Assayer's supplies		880.84
Printing and stationery		226.18
Premium on bonds		630.00
Contingencies		200.86
Electric burglar alarm service		300.00
Wages:—		
G. Middleton		2,650.00
J. B. Farquhar		1,900.00
A. Kaye		1,800.00
H. Freeman		1,239.71
D. Robinson		1,575.00
G. N. Ford		1,500.00
T. B. Younger		1,200.00
R. Allison		1,080.00
E. A. Pritchett		900.00
H. E. Warburton		793.33
R. D. McLellan		528.23
T. Campbell		191.94
Balance unexpended		3,023.37
	$24,174.43	$24,174.43

LIST OF REPORTS, BULLETINS, ETC., PUBLISHED DURING THE YEAR 1915.

S. Groves,
Editor Department of Mines.

266. Bulletin No. 9: Investigation of the Peat Bogs and the Peat Industry of Canada, 1911 and 1912, by A. Anrep. Published March 13, 1915.
279. Building and Ornamental Stones of Canada—Vol. III: The Province of Quebec, by Wm. A. Parks, Ph.D. Published January 9, 1915.
281. The Bituminous Sands of Northern Alberta, Report on—by S. C. Ells, M.E. Published March 20, 1915.
285. Annual Summary Report of the Mines Branch for 1913. Published April 3, 1915.
291. The Petroleum and Natural Gas Resources of Canada. Report on, by F. G. Clapp, A.M., and others:
    Vol. I: Technology and Exploitation. Published May 26, 1915.
    Vol. II: Occurrence of Petroleum and Natural Gas in Canada. Published December 9, 1915.
299. Peat, Lignite and Coal; their Value as Fuels for the Production of Gas and Power in the By-Product Recovery Producer. Report on—by B. F. Haanel, B.Sc. Published February 27, 1915.
305. The Non-metallic Minerals used in Canadian Manufacturing Industries. Report on—by Howells Frechette, M.Sc. Published March 4, 1915.
309. The Physical Properties of Cobalt, Part II. Report on—by H. T. Kalmus, B.Sc., Ph.D. Published February 11, 1915.
315. The Production of Iron and Steel during the Calendar Year 1913, Bulletin on—by John McLeish, B.A. Published January 19, 1915.
317. The Production of Copper, Gold, Lead, Nickel, Silver, Zinc, and other Metals of Canada, during the Calendar Year 1913. Bulletin on—by C. T. Cartwright, B.Sc., Published January 23, 1915.
318. The Production of Cement, Lime, Clay Products, and other Structural Materials, during the Calendar Year 1913. Bulletin on—by J. McLeish, B.A. Published January 19, 1915.
319. General Summary of the Mineral Production of Canada during the Calendar Year 1913. Bulletin on—by J. McLeish, B.A., Published January 27, 1915.
320. The Mineral Production of Canada during the Calendar Year 1913. Annual Report on—by J. McLeish, B.A. Published April 26, 1915.
323. The Products and By-products of Coal. Report on—by Edgar Stansfield, M.Sc., and F. E. Carter, B.Sc., Dr. Ing. Published July 29, 1915.
325. The Salt Industry of Canada. Report on—by L. H. Cole, B.Sc. Published August 30, 1915.
331. The Investigation of Six Samples of Alberta Lignites. Report on—by B. F. Haanel, B.Sc., and J. Blizard, B.Sc. Published August 12, 1915.
333. Preliminary Report on the Mineral Production in Canada during the Calendar Year 1914. By J. McLeish, B.A. Published March 2, 1915.
334. Electro-plating with Cobalt and its Alloys. Report on—by H. T. Kalmus, B.Sc., Ph.D. Published October 14, 1915.
336. Notes on Clay Deposits near McMurray, Alberta. Bulletin No. 10—by S. C. Ells, B.A., B.Sc. Published April 23, 1915.
344. Electrothermic Smelting of Iron Ores in Sweden. Report on—by Alfred Stansfield, D.Sc., A.R.S.M., F.R.S.C. Published November 12, 1915.
348. Production of Coal and Coke in Canada during the Calendar Year 1914. by J. McLeish, B.A. Published December 20, 1915.
349. Production of Iron and Steel in Canada, during the Calendar Year 1914. Bulletin on—by J. McLeish, B.A. Published December 7, 1915.

FRENCH TRANSLATIONS PUBLISHED DURING THE YEAR 1915.

Marc Sauvalle,

Chief of Publishing and Translating Division.

179. French translation: The Nickel Industry, with special reference to the Sudbury region, Ont., by A. P. Coleman. Published December 2, 1915.
286. French translation: General Summary Report of Mines Branch, Department of Mines for 1913. Published October 15, 1915.
287. French translation: Production of iron and steel in Canada, during the year 1912, by J. McLeish. Published April 7, 1915.
289. French translation: Production of cement, lime, clay products, stone, and other structural materials during 1912. Published February 18, 1915.
308. French translation: An investigation of the coals of Canada with reference to their economic qualities: as conducted at McGill University under the authority of the Dominion Government. Report on—by J. B. Porter, E.M., D.Sc., R. J. Durley, Ma.E., and others:
    - Vol. II. Boiler and gas producer tests. Published August 9, 1915.
    - Vol. III. Appendix I. Coal washing tests and diagrams. Published September 1, 1915.
314. French translation: Mines Branch Bulletin No. 2: Iron Ore Deposits, Bristol Mines, Pontiac Co., Quebec, by E. Lindeman. Published May 27, 1915.

ACCOUNTANT'S STATEMENT MINES BRANCH.

Statement of Appropriations and Expenditure, 1914–15[1].

[1] This financial statement covers nine months of the calendar year which is also the period of greatest activity. Therefore it has been deemed advisable to include the financial report most closely associated with the work described in this summary report. The statement for the previous financial year is also published herewith.

Mines Branch		Grant	Expenditure	Grant not used
Investigation of ore deposits, economic minerals, peat bogs, determination of fuel values of coals, lignite and peat of Canada, including wages of machinist and labourers, and additional machinery; investigation of ore dressing, including wages of labourers, machinery and equipment of laboratory; collection of information regarding minerals, and metallurgical industries and operations		$91,000.00	$66,913.79	$24,086.21
Publication of reports, translation of reports into French, purchase of books, stationery, chemical laboratories' expenses, apparatus, instruments, office contingencies, additional assistance		69,500.00	69,498.10	1.90
Investigation of metallurgical problems of economic importance		10,000.00	10,000.00	
For apparatus and equipment, salaries of inspectors, chemists, machinist, clerical assistance, and travelling expenses in connexion with the investigations of the manufacture and storage of explosives in Canada		55,000.00	456.71	54,543.29
Completion of experiments in zinc smelting		10,000.00	8,831.11	6,822.08
Under Statute: Zinc Investigation: Advance from 1913–14	$2,335.41			
Zinc Investigation: Balance unexpended, 1913–14	3,317.78			
		5,653.19		
Civil Government Contingencies		1,500.00	1,042.66	457.34
		$242,653.19	$156,742.37	$85,910.82
Dominion of Canada Assay Office, Vancouver, B.C.				
Maintenance of Assay Office, Vancouver, B.C.		20,000.00	15,955.88	4,044.12

May 26, 1915.

(*Signed*) JNO. MARSHALL,
Accountant.

ACCOUNTANT'S STATEMENT MINES BRANCH.

STATEMENT OF APPROPRIATIONS AND EXPENDITURE, 1913–14[1].

[1] This fiscal year ends March 31, 1914.

Mines Branch	Grant	Expenditure	Grant not used
Investigation of ore deposits, economic minerals, peat bogs, determination of fuel values of coals, lignite and peat of Canada, including wages of machinist and labourers, and additional machinery; investigation of ore dressing, including wages of labourers, machinery and equipment of laboratory; collection of information regarding minerals, and metallurgical industries and operations	$77,000.00	$54,799.29	$22,200.71
Publication of reports, translation of reports into French, purchase of books, stationery, chemical laboratories' expenses, apparatus, instruments, office contingencies, additional assistance	69,500.00	69,030.90	469.10
Investigation of metallurgical problems of economic importance	10,000.00	9,999.86	0.14
For apparatus and equipment, salaries of inspectors, chemists, machinist, clerical assistance, and travelling expenses in connexion with the investigations of the manufacture and storage of explosives in Canada	55,000.00	480.24	54,519.76
Zinc investigations per Bill No. 182	34,266.77	30,948.99	3,317.78
Investigation of quartz and copper deposits in the Yukon	9,000.00	8,620.36	379.64
	$254,766.77	$173,879.64	$80,887.13
DOMINION OF CANADA ASSAY OFFICE, VANCOUVER, B.C.			
Maintenance of Assay Office, Vancouver, B.C.	27,000.00	14,868.83	12,131.17

May 22, 1914.

(*Signed*) JNO. MARSHALL,
Accountant.

STATEMENT OF APPROPRIATIONS AND EXPENDITURE BY MINES BRANCH FOR YEAR ENDING MARCH 31, 1914.

	Appropriation	Expenditure
Amounts voted by Parliament	$329,341.77	
Receipts for Assays and Analyses	377.85	
Civil List Salaries		$68,199.86
Publication of Reports		46,564.75
Zinc Investigations		28,613.58
Fuel Testing Plant, Ottawa		15,782.82
Concentrating Laboratory		15,775.53
Metallurgical Investigations		9,999.86
Quartz Investigations		8,620.36
Printing, stationery, books, mapping material		8,242.66
Investigation of Iron Ore deposits		7,876.67
Wages, outside service		5,916.41
Laboratory		3,358.99
Investigation of Peat and Coal		3,213.71
International Geological Congress		2,627.89
Investigation of Tar Sands		2,610.57
Monograph on Petroleum and Natural Gas		2,002.85
Miscellaneous		1,985.04
Investigation of Copper deposits		1,828.51
Publication of Maps		1,663.36
Monograph on Building Stones		1,428.89
Instruments		668.18
Travelling Expenses		655.08
Investigation of Explosives		480.24
Monograph on Mica		450.60

STATEMENT OF APPROPRIATIONS AND EXPENDITURE BY MINES BRANCH FOR YEAR ENDING MARCH 31, 1915.

		Appropriations	Expenditure
Amounts voted by Parliament:—			
General Appropriations.......	$238,817.78		
Civil List Salaries............	92,812.50		
Civil Government Contingencies	1,500.00		
		$333,130.28	
Advance from 1913–14, accounted for in 1914–15		2,335.41	
Receipts for Assays and Analyses..............		359.50	
Civil List Salaries..........................			$77,717.97
Civil Government Contingencies...............			1,042.66
Wages......................................			5,810.76
Publication of Reports.......................			52,372.27
Fuel Testing Plant..........................			14,486.67
Concentrating Laboratory....................			17,540.47
Ceramic Laboratory.........................			2,708.06
Chemical Laboratory........................			1,983.55
Printing, stationery, books, mapping material....			5,712.85
Publication of Maps........................			522.50
Miscellaneous..............................			2,593.56
Instruments................................			1,031.42
Investigation re Metallurgical Problems........			10,000.00
" Iron Ores...................			11,322.61
" Zinc.......................			8,831.11
" Tar Sands..................			8,486.68
" Peat and Coal..............			3,308.00
" Mineral Waters.............			2,985.09
" Moulding Sands.............			1,489.65
" Limestones.................			946.17
" Salt Deposits..............			505.75
" Non-Metallic Minerals.........			504.43
" Quartz....................			479.68
" Explosives................			456.71
" Oil Shales................			165.98
" Copper Deposits............			114.70
" Manufacturer's Raw Materials.			62.17
Monograph on Building Stones................			1,489.65
Mining and Metallurgical Industry............			143.47
Mineral Statistics Industry.................			5.25
Balance unexpended..................			101,005.35
		$335,825.19	$335,825.19

CASUAL REVENUE.

Sales of Publications..$237.42

Summary		Vote	Expenditure	Unexpended Balance
Civil Government Salaries..........................		$92,812.50	$77,717.97	$15,094.53
Investigation of ore deposits, economic minerals, etc..................................		91,000.00	66,913.79	24,086.21
Printing, books, stationery, apparatus, chemical laboratories' expenses, miscellaneous.........		69,500.00	69,498.10	1.90
Investigation of metallurgical problems of economic importance..................................		10,000.00	10,000.00	
Investigation of manufacture and storage of explosives in Canada............................		55,000.00	456.71	54,543.29
Completion of experiments in zinc smelting.......		10,000.00		
Under Statute: Zinc Investigation: Advance from 1913–14..............	$2,335.41		11	6,822.08
Zinc Investigation: Balance unexpended, 1913–14....................	3,317.78			
		5,653.19		
Civil Government Contingencies.................		1,500.00	1,042.66	457.34
		$335,465.69	$234,460.34	$101,005.35

ACCOUNTANT'S STATEMENT, MINES BRANCH.

Statement of Appropriations and Expenditures, 1915–16.[1]

[1] This Financial Statement covers nine months of the calendar year, which is also the period of greatest activity. Therefore, it has been deemed advisable to include report most closely associated with the work described in this Summary Report. The statement for the previous financial year is also published herewith.

Mines Branch	Grant	Expenditure	Balance
Investigations of ore deposits, economic minerals, peat bogs, determination of fuel values of coals, lignite and peat of Canada, including wages of machinist and labourers, and additional machinery; investigation of ore dressing, wages of labourers, machinery and equipment of laboratory; collection of information regarding minor minerals, and metallurgical industries and operations....................................	$62,000.00	$57,993.28	+$4,006.72
Publication of reports, translation of reports into French, purchase of books, stationery, chemical laboratories supplies, apparatus, instruments, office contingencies, additional assistance.....	$67,000.00	67,695.13	−695.13
For investigations of the manufacture and storage of explosives in Canada, apparatus and equipment, salaries of inspectors, chemist, machinist, clerical assistance and travelling expenses.....	5,000.00	1,085.81	+3,914.19
Investigation of iron industry by Special Committee....................................	10,000.00	1,005.68	+8,994.32
Practical tests in road making of tar sands of Athabaska.................................	5,000.00	3,214.12	+1,785.88
Civil Government Contingencies.................	1,500.00	717.81	+ 782.19
	$150,500.00	$131,711.83	$18,788.17

Dominion of Canada Assay Office, Vancouver.

Maintenance of Assay Office, Vancouver, B.C.....	$20,000.00	$16,926.63	$3,023.37

Statement of Appropriations and Expenditure by Mines Branch for year ending 31st March, 1916.

		Appropriations	Expenditure
Amounts voted by Parliament:—			
General Appropriations	$149,000.00		
Civil List Salaries	96,900.00		
Civil Government Contingencies	1,500.00		
		$247,400.00	
Receipts for Assays and Analyses		373.00	
Civil List Salaries			$86,760.42
Civil Government Contingencies			717.81
Publication of Reports, $42,074.02, less unpaid Printing Bureau, $695.13			41,378.89
Translation of Reports			3,029.40
Publication of Maps			3,462.34
Fuel Testing Plant			14,355.86
Concentrating Laboratory			12,098.62
Ceramic Laboratory			1,388.91
Chemical Laboratory			1,215.66
Metallographic Laboratory			204.75
Machinery, parts and supplies			8,724.21
Wages, mechanics and labourers			7,504.70
Printing, stationery, books, mapping material			6,558.65
Investigation re Tar Sands, Alberta			4,787.29
Tar Sands Paving, Edmonton, Alberta			3,214.12
Investigation re Iron Ores			3,534.83
Investigation re Non-metallic minerals			2,801.42
Investigation re Building Stones			2,798.99
Investigation re Moulding Sands			1,598.82
Investigation re Clay Deposits			1,534.13
Investigation re Peat and Coal			1,515.01
Forward		$247,773.00	$209,184.83

	Appropriation	Expenditure
Forward	$247,773.00	$209,184.83
Special Investigations re Iron Ore		1,321.14
Investigation re Limestones		1,117.98
Investigation re Explosives		1,085.81
Investigation re Mineral Waters		521.10
Investigation re Ore Deposits		132.41
Investigation re Oil Shales		49.25
Investigation re Copper Deposits		27.15
Instruments		1,538.23
Miscellaneous		1,474.24
Postage and Telegrams		963.91
Subscriptions, Membership Fees, etc		406.50
Advertising		137.50
Coal Tests		136.04
Brokerage Fees		54.03
Balance unexpended		29,622.88
	$247,773.00	$247,773.00

CASUAL REVENUE.

Sales of Publications	383.22	
Hudson Bay Co., for canoe	65.00	
S. C. Ells, provisions, camp materials	47.00	
S. Young, for canoe	12.00	
Baker and Co., Newark, N.J., platinum scrap	.18	
T. Denis, one old arithmometer	10.00	
		$517.40

Summary	Appropriation	Expenditure	Expenditure greater than vote	Expenditure less than vote
Civil Government Salaries	$96,900.00	$86,760.42		$10,139.58
Investigation of ore deposits, economic minerals, etc	62,000.00	57,993.28		4,006.72
Printing, books, stationery, apparatus, chemical laboratories expenses, miscellaneous	67,000.00	67,695.13	$695.13	
Investigation of manufacture and storage of explosives in Canada	5,000.00	1,085.81		3,914.19
Investigation of Iron Industry by Special Committee	10,000.00	1,005.68		8,994.32
Practical tests in road making of Tar Sands of Athabaska	5,000.00	3,214.12		1,785.88
Civil Government Contingencies	1,500.00	717.81		782.19
	$247,400.00	$218,472.25	$695·13	$29,622.88

(*Signed*) **Jno. Marshall**
Accountant Department of Mines.

APPENDIX

EUGENE HAANEL, Ph.D.,
Director of Mines.

SIR,—I beg to submit herewith, the annual preliminary report on the mineral production of Canada in 1915.

The figures for production in 1915, while subject to revision, are based upon direct returns from mine and smelter operators and are fairly complete.

Special acknowledgments are due to those operators who have promptly furnished reports of their operations during the year.

When complete returns shall have been received the usual annual report will be prepared containing in greater detail the final statistics as well as information relating to exploration, development, prices, markets, imports and exports, &c.

I am, sir, your obedient servant,
JOHN McLEISH.

Division of Mineral Resources and Statistics,
February 21, 1916.

PRELIMINARY REPORT ON THE MINERAL PRODUCTION OF CANADA.

DURING THE CALENDAR YEAR 1915.

As a result of the demand created by the war, the metal mining industry has, in 1915, shown the highest production ever recorded and notwithstanding the greatly decreased production of materials of construction, such as cement, clay and stone quarry products, a very large increase is still shown in the total mineral output, over that of the previous year.

The total value[1] of the metal and mineral production in 1915, as shown in the preliminary report presented herein, was $138,513,750, compared with $128,863,075 in 1914, and $145,634,812 in 1913, the latter being the highest production recorded. The increase in 1915 over 1914 was thus $9,650,675, or 7·49 per cent, but the output is still less than that in 1913 by $7,121,062.

Without attempting to discuss at length the effect of the war upon the Canadian mining industry, it may be remarked that the demand for the metals, copper, lead, nickel, and zinc, led to great activity in the operation of the already developed deposits of these metals, and also, later in the year, to the opening up of old and the exploitation of new deposits. The capacities of steel furnaces were taxed to the utmost to meet the demand for shell steel.

The fact that under war conditions it was desirable that our metals should become available for commercial or national use, entirely within the country and that we should be less dependent, even upon a friendly neutral, for their recovery in smelters and refineries has stimulated the development of our smelting and refining operations.

Amongst non-metallic minerals the recovery of benzol and toluol in by-product coke oven operations was a direct result of the war, as was also the activity in the mining and shipment of magnesite and of chrome ores.

The limitation placed by the Government upon the export of certain minerals and metals may have caused inconvenience and interruption to certain industries but these were usually adjusted by the issue of special licenses for export where it could be shown that such export was not for enemy destination but was in the interest of Great Britain and her allies.

[1] In presenting a total valuation of the mineral production as is here given, it should be explained that the production of the metals copper, gold, lead, nickel, and silver is given as far as possible on the basis of the quantities of metals recovered in smelters, and the total quantities in each case are valued at the average market price of the refined metal in a recognized market. There is thus included in some cases the values that have accrued in the smelting or refining of metals outside of Canada.

THE MINERAL PRODUCTION OF CANADA IN 1915.

SUBJECT TO REVISION.

Product		Quantity	Value
METALLIC			$
Antimony	Lbs.	961,040	192,208
Cobalt, metallic	"	211,610	502,388
Cobalt, oxide	"	379,219	
Nickel, metallic	"	55,325	42,193
Nickel, oxide	"	200,032	
Copper, value at 17·275 cents per pound	"	102,612,486	17,726,307
Gold	Ozs.	916,076	18,936,971
Iron, pig, from Canadian ore	*Tons	158,598	1,740,808
Iron ore, sold for export	"	93,444	187,682
Lead, value at 5·60 cents per pound	Lbs.	45,377,065	2,541,116
Molybdenite	"	28,600	28,460
Nickel, value at 30 cents per pound	"	68,077,823	20,423,348
Silver, value at 49·684 cents per ounce	Ozs.	28,401,735	14,088,397
Zinc ore	Tons	15,553	636,204
Total		....	77,046,082
NON-METALLIC			
Actinolite	Tons	220	2,420
Arsenic, white	"	2,291	141,830
Asbestos	"	113,115	3,491,450
Asbestic	"	25,700	21,819
Chromite (a)	"	11,486	162,618
Coal	"	13,209,371	31,957,757
Corundum	"	262	33,138
Feldspar	"	15,455	59,124
Graphite	"	2,610	121,023
Grindstones	"	2,580	35,768
Gypsum	"	470,335	849,928
Magnesite	"	14,779	126,535
Manganese	"	47	5,460
Mica		....	81,021
Mineral pigments—			
Barytes	"	550	6,875
Ochres	"	6,248	48,353
Mineral water		....	118,796
Natural gas	M. cu. ft.	18,319,710	3,300,825
Peat	Tons	300	1,050
Petroleum	Brls.	215,464	300,572
Phosphate	Tons	217	2,502
Pyrites	"	296,910	1,028,678
Quartz	"	127,108	205,153
Salt	"	119,900	600,226
Talc	"	11,885	40,554
Tripolite	"	317	12,119
Total		....	42,755,594
STRUCTURAL MATERIALS AND CLAY PRODUCTS			
Cement, Portland	Brls.	5,681,032	6,977,024
Clay products—			
Brick: common, pressed, paving		....	2,341,483
Sewerpipe		....	795,646
Fireclay, drain tile, pottery, etc		....	781,071
Kaolin	Tons.	1,300	13,000

The Mineral Production of Canada—*Concluded.*

Product		Quantity	Value
Lime	Bush.	4,932,767	1,015,878
Sand and gravel		....	2,098,683
Sand-lime brick	No.	23,211,802	182,651
Slate	Sq.	397	2,039
Stone—			
Granite		....	1,634,084
Limestone		....	2,504,731
Marble and Sandstone		....	365,784
Total structural materials and clay products		....	18,712,074
All other non-metallic		....	42,755,594
Total value, metallic		....	77,046,082
Grand total, 1915		....	138,513,750

* Tons of 2,000 pounds.
(a) Additional returns make total shipment: 14,291 tons value $208,718—See "Chromite" in text.

The mining and metallurgical industries include a great variety of products so that in dealing with the industry as a whole the total value presents the only means of comparison, nevertheless quantities of production and prices are at all times the items of essential importance.

A comparison of the production of the more important mineral products in 1915 with that of 1914, is shown in the accompanying table.

Increase or Decrease in Principal Products, 1915.

Principal Products		Increase (+) or Decrease (−) in Quantity		Increase (+) or Decrease (−) in Value	
			%	$	%
Copper	Lbs.	+26,876,526	35·49	+ 7,424,701	72·07
Gold	Ozs.	+ 142,898	18·48	+ 2,953,964	18·48
Pig iron	Tons.	+ 130,555	16·67	+ 1,589,963	15.90
Lead	Lbs.	+ 9,039,300	24·88	+ 914,548	56·19
Nickel	"	+22,559,886	49·56	+ 6,767,967	49·56
Silver	Ozs.	− 48,086	0·17	− 1,505,234	9·65
Total metallic		....	......	+17,659,463	29·73
Asbestos and Asbestic	Tons	+ 21,242	18·07	+ 603,463	20·74
Coal	"	− 428,158	3·14	− 1,514,044	4·52
Gypsum	"	− 46,545	9·90	− 306,279	26·49
Natural gas	M. ft.	− 3,372,794	15·09	− 183,902	5·28
Petroleum	Brls.	+ 659	0·31	− 42,552	12·40
Pyrites	Tons	+ 68,596	30·04	+ 284,170	38·16
Salt	"	+ 12,862	12·02	+ 106,578	21·59
Cement	Brls.	− 1,491,448	20·79	− 2,210,900	24·06
Clay products		....	......	− 2,940,757	32·01
Lime	Bush.	− 2,095,815	28·92	− 344,750	33·94
Sand and Gravel		....	......	− 406,628	16·23
Stone		....	......	− 964,457	17·63
Total non-metallic		....	......	− 8,008,788	11·53
Grant total		....	......	+ 9,650,675	7·49

It will be observed that there has been an increased production in all metals with the exception of silver. The total value of the metallic production in 1915 was $77,046,082 as compared with $59,386,619 in 1914, and $66,361,351 in 1913, the increase over 1914 being nearly 30 per cent, and that over 1913 the highest previous year, about 16 per cent. The production of nickel, copper and zinc are the highest that have been recorded in these metals. The quantity of nickel was 50 per cent greater than in 1914, copper over 35 per cent greater, lead nearly 25 per cent greater, gold over 18 per cent and pig iron nearly 17 per cent. The falling off in silver was only 48,000 ounces or less than two-tenths of one per cent. Owing to the high prices of copper and lead the total values of these metals show increases of 72 per cent and 56 per cent respectively.

Although the prices of nearly all metals have been high they have in most cases been exceeded in comparatively recent years except possibly in antimony and zinc, and some of the rarer metals.

Compared with 1914 the average price of copper shows an increase of 27 per cent, lead an increase of 27 per cent, spelter an increase of 154 per cent, antimony (ordinaries) an increase of 246 per cent, silver a decrease of 9·4 per cent and tin an increase of 12·2 per cent.

Metal Prices.

		1910	1911	1912	1913	1914	1915
		Cts.	Cts.	Cts.	Cts.	Cts.	Cts.
Antimony (ordinaries)	Per lb.	7·386	7·540	7·760	7·520	8·763	30·280
Copper, New York	"	12,738	12·376	16·341	15·269	13·602	17·275
Lead "	"	4·446	4·420	4·471	4·370	3·862	4·673
" London	"	2·807	3·035	3·895	4·072	4·146	4·979
" Montreal*	"	3·246	3·480	4·467	4·659	4·479	5·600
Nickel, New York	"	40·000	40·000	40·000	40·000	40·000	45·000
Silver, "	Per oz.	53·486	53·304	60·835	59·791	54·811	49·684
Spelter, "	Per lb.	5·520	5·758	6·943	5·648	5·213	13·230
Tin, "	"	34·123	42·281	46·096	44·252	34·301	38·500

* Quotations furnished by Messrs. Thomas Robertson and Company, Montreal, Que.

The total value of the non-metallic production in 1915 including clay and quarry products, etc., was $61,467,668 as against $69,476,456 in 1914; $79,273,461 in 1913. Compared with 1914 the decrease was $8,008,788, or 11·5 per cent, while compared with 1913 the falling off was $17,805,793 or 22·5 per cent.

It will be seen that the largest decreases in 1915 occurred in materials of construction such as cement, clay products, lime, sand, and gravel, and stone and quarry products, the falling off varying from 16 to nearly 34 per cent. There was, however, also a smaller production of coal, natural gas and gypsum. On the other hand there were increases in the shipments of asbestos, chromite, graphite, magnesite, pyrites, and salt.

The record of mineral production by provinces shows the relative importance of the provinces in the same order as in the previous year with the exception that Quebec and Alberta change places, the former having the larger production in 1915. An increase in production is shown in the provinces of Nova Scotia, Quebec, Ontario, and British Columbia, and a decrease in New Brunswick, Manitoba, Saskatchewan, Alberta and the Yukon district. Ontario again has the largest output with a value of $61,800,178, or 44·6 per cent of the total, and showing an increase over 1914 of $8,765,501, or 16·5 per cent. British Col-

umbia occupies second place with a value of $28,932,658, or 20·9 per cent of the total and showing an increase of $4,768,619, or 19·7 per cent over 1914; Nova Scotia is third with a production valued at $18,126,672, or 13·1 per cent of the total and showing an increase of $542,033, or 3·1 per cent over 1914. Quebec comes fourth with a value of $12,159,436, or 8·8 per cent of the total, and an increase over 1914 of $322,507, or 2·7 per cent. Alberta occupies fifth place with a production of $9,915,282, or 7·2 per cent of the total and showing a decrease of $2,768,952, or 21·8 per cent compared with 1914. The Yukon district mineral production, including copper and coal as well as gold, is sixth, with a value of $4,915,863, or 3·6 per cent of the total and a falling off from 1914 of $502,322, or 9·3 per cent. Manitoba's production was $1,351,604, a falling off of $1,061,885, or 44 per cent. New Brunswick's production was $916,329, a decrease of $98,241, or 9·7 per cent, and the production of Saskatchewan was the smallest, being $395,728, or less than that of 1914 by $316,585, or 44·4 per cent.

Mineral Production by Provinces, 1914 and 1915.

	1914		1915		Increase (+) or Decrease (−)		
	Value of Production	Per cent of total	Value of Production	Per cent of total			
	$	%	$	%		$	%
Nova Scotia	17,584,639	13·68	18,126,672	13·09	+	542,033	3·08
New Brunswick	1,014,570	0·79	916,329	0·66	−	98,241	9·68
Quebec	11,836,929	9·21	12,159,436	8·78	+	322,507	2·72
Ontario	53,034,677	41·01	61,800,178	44·62	+	8,765,501	16·53
Manitoba	2,413,489	1·88	1,351,604	0·97	−	1,061,885	44·00
Saskatchewan	712,313	0·55	395,728	0·28	−	316,585	44·44
Alberta	12,684,234	9·87	9,915,282	7·16	−	2,768,952	21·83
British Columbia	24,164,039	18·80	28,932,658	20·89	+	4,768,619	19·73
Yukon	5,418,185	4·21	4,915,863	3·55	−	502,322	9·27
Dominion	128,863,075	100·00	138,513,750	100·00	+	9,650,675	7·49

GOLD.

The total production of gold in placer and mill bullion and in smelter products in 1915 is estimated at 916,076 fine ounces valued at $18,936,971, as compared with 773,178 fine ounces valued at $15,983,007 in 1914, an increase of $2,953,964 or 18·5 per cent. Although the production has more than doubled since 1907 it has not yet reached the high mark attained during Klondike's best years. The 1915 output was exceeded during each of the four years from 1899 to 1902.

Of the total production in 1915 about $5,510,987 was derived from placer and alluvial mining, $9,195,307 in bullion and refined gold and $4,230,677 contained in matte, blister copper, residues and ores exported.

The production in Nova Scotia was about $137,178, or over twice the output of the previous year. The pyrites ores of Quebec carry small quantities of gold and silver though the producers are not paid therefor. No placer recovery was reported from this province.

Ontario has now become the largest gold-producing province in Canada, the production in 1915 from fifteen properties being reported as $8,386,956, or 44 per cent of the total production in Canada, as against a production in 1914

of $5,545,509 an increase of $2,841,447, or 51 per cent. The Hollinger and Acme mines contributed about one-half of the output in 1915 and the Dome nearly one-fifth of the total.

No production of gold has been reported in either Manitoba or Saskatchewan although some development work has been done. From Alberta record has been obtained of the recovery of about $4,000 of alluvial gold.

The production in British Columbia was $5,628,982 including $755,000 estimated by the provincial mineralogist as being the output of placer workings, and $4,873,982 recovered from milling and smelting ores. In 1914 the production was $5,224,393 including $565,000 from placer workings and $4,659,393 from milling and smelting ores.

The Yukon production in 1915, including a small recovery from copper ores, was $4,755,721, a decrease of $369,653 from the 1914 production. The amount of gold on which royalty was paid during the year 1915 according to the records of the Mining Lands and Yukon Branch, Interior Department, was 287,254·15 ounces, as against 309,691·17 ounces in 1914, and 352,900·04 ounces in 1913. For purposes of the royalty this gold is valued at $15 per ounce although the actual value is probably nearer $16.50. The receipts at the Dominion of Canada Assay Office, Vancouver, were 87,284·35 ounces, valued at $1,421,292·37 or an average of $16·28 per ounce.

The exports of gold bearing dust, nuggets, gold in ore, etc., in 1915 are reported by the Customs Department as $16,528,143.

SILVER.

The production of silver was 28,401,735 ounces valued at $14,088,397 as against 28,449,821 ounces in 1914, valued at $15,593,630. Silver is the principal metal that did not show an increased production in 1915. The falling off in quantity was very small however amounting to only 48,086 ounces. Owing to the lower price of silver the decrease in total value was $1,505,234 or over 9·6 per cent.

Of the total production in 1915, 24,653,057 ounces, or about 86·8 per cent is credited to Ontario.

The production from the ores of Cobalt and other silver camps was 23,568,147 ounces including 19,893,639 ounces in bullion recovered in smelters and cyanide plants in Canada and 3,674,508 ounces estimated as recovered from ores exported to United States smelters. The quantity credited to gold ores was 84,910 ounces. The total production in 1914 was estimated at 25,139,214 compared with which the 1915 recovery shows a decrease of 1,571,067 ounces.

Of the silver in bullion 10,623,307 ounces were produced in smelters in Southern Ontario, and 9,270,332 ounces in the mills at Cobalt, the total in bullion being over 84 per cent of the production of the district.

The production in British Columbia, representing refined silver, silver contained in smelter products, and estimated recoveries from ores exported, was in 1915, about 3,628,727 ounces as compared with 3,159,897 ounces in 1914, an increase of 468,830 ounces, or over 14 per cent.

In Quebec province there is a small silver content in the pyrites ores shipped while in the Yukon 58,382 ounces are estimated as being contained in the placer gold produced and recovered from copper ores.

The exports of silver bullion and silver in ore, etc., as reported by the Customs Department, were: 27,672,481 ounces valued at $13,812,038.

The price of silver in New York varied between a minimum of 46¼ cents in September and a maximum of 56 cents in December, averaging for the year 49·684 cents, a decrease of 5·127 cents from the average price in 1914.

COPPER.

The copper output in 1915 was the highest recorded. The production in smelters together with the estimated recoveries or amounts paid for in ores exported amounted to 102,612,486 pounds which at the average New York value of refined copper would be worth $17,726,307. The highest previous production was in 1912 when an output of 77,832,127 pounds was reached. Compared with the production in 1914 which was 75,735,960 pounds valued at $10,301,606 an increase is shown of 26,876,526 pounds or 35 per cent and in total value of $7,424,701, or 72 per cent.

Of the total 1915 production 42,050,347 pounds were contained in blister copper, 44,230,052 in copper and copper nickel matte and 16,332,087 recovered from ores exported.

The production in Quebec from pyrites ore was 6,082,003 pounds as against 4,201,497 pounds in 1914.

The Ontario production is derived chiefly from the nickel-copper ores of the Sudbury district and of the Alexo mine, although there is a small amount of copper contained in the silver ores shipped from Cobalt, some of which is paid for. There was also a small shipment from the old Massey mine which was re-opened during the year.

The production in 1915 is reported as 39,303,279 pounds as against 28,948,211 pounds in 1914 an increase of 10,355,068 pounds or 35·7 per cent. Further detail respecting production will be found in the remarks on nickel.

British Columbia also shows a largely increased production in 1915, the total being 56,692,988 pounds as against 41,219,202 pounds in 1914 an increase of 15,473,786 pounds or 37·5 per cent. The 1915 production in this province included 47,064,234 pounds recovered in blister and matte etc., and 9,628,754 recovered from ores shipped to smelters outside of Canada. The Coast mines including the Britannia, Texada Island and Anyox mines, etc., are credited with 33,980,508 pounds and the Trail Creek and Boundary mines with 22,712,480 pounds.

The Yukon production is reported as 534,216 pounds as against 1,367,050 pounds in 1914.

The New York price of electrolytic copper rose from a minimum of 13 cents per pound in January to 20 cents in June, falling again to 16 cents in August, then rising steadily to the end of the year, reaching a maximum of 22 cents at the end of December. The average monthly price for the year was 17·275 cents, as compared with an average of 13·602 cents in 1914, an increase of 3·673 cents, or 27 per cent. This is the highest average monthly price since 1907, when 20·004 cents per pound was reached.

Exports of copper according to Customs records were; copper fine in ore, etc., and copper in pigs 102,729,579 pounds valued at $12,460,356, there were also exports of old and scrap copper amounting to 4,161,600 pounds valued at $616,553.

The total value of the imports of copper in 1915 are recorded as $3,957,770 as against $4,256,901 in 1914. The imports in 1915 included 20,245,407 pounds of copper in pigs, ingots and manufactures, valued at $3,593,818; other manufactures valued at $264,670, and copper sulphate 1,854,850 pounds, valued at $99,282.

The imports in 1914 included 26,280,815 pounds crude and manufactured copper valued at $3,983,322, copper sulphate 1,143,039 pounds valued at $53,802 and other manufactures of copper valued at $219,777.

NICKEL

Refined metallic nickel is now being recovered in Canadian refineries but only in small quantities and as a by-product in the smelting and refining of the

silver-cobalt-nickel ores of the Cobalt district, nickel oxide having been recovered in these smelters for several years. The nickel-copper ores of the Sudbury district supplemented by a small tonnage of similar ores from the Alexo mine in Timiskaming, north of Cobalt, are the main sources of nickel production, which in 1915 increased nearly 50 per cent as compared with 1914 and is greater than the production in 1913, the largest previous record, by over 37 per cent.

The nickel-copper ore, derived from 12 separate mines, is reduced in smelters and converters to a Bessemer matte containing from 77 to 82 per cent of the combined metals and shipped in that form to Great Britain and the United States for refining, the product of the Canadian Copper Company going to New Jersey and that of the Mond Nickel Company to Wales. A portion of the matte produced by the Canadian Copper Company is used without the intermediate refining of either metal for the direct production of monel metal, an alloy of nickel and copper.

The total production of matte in 1915 was 67,703 tons, containing 39,216,165 pounds of copper and 68,077,823 pounds of nickel and valued by the producers at $10,352,344. The tonnage of ore smelted (part being previously roasted) was 1,272,283. The production in 1914 was 46,396 tons of matte containing 28,895,825 pounds of copper and 45,517,937 pounds of nickel and valued at $7,189,031.

The reported recovery of nickel from the ores of the Cobalt district was 55,325 pounds of metals and 200,032 pounds of nickel oxide. The recovery in 1914 was 392,512 pounds of nickel oxide.

The exports of nickel are reported by the Customs Department as 66,410,400 pounds valued at $7,394,446 or an average of 11·13 cents per pound. Since about 80 per cent of the Canadian nickel production is exported to the United States, it may be of interest to add to the Canadian statistics a record of the imports (eleven months only in 1915) of nickel into and the exports from the United States.

The exports of nickel from the United States during the eleven months ending November were 24,503,585 pounds valued at $9,299,234 or an average of 37·95 cents per pound. More than 50 per cent of these exports went to the United Kingdom. The value of the United States exports in 1914 ranged from 31 to 39 cents per pound and averaged about 34 cents.

It will be noted that a larger quantity of nickel finds its way to the United Kingdom through United States refineries than is exported directly from Canada.

The price of refined nickel in New York remained fairly constant during the first seven months of the year, quotations published by the Engineering and Mining Journal being 40 to 45 cents per pound for ordinary forms with 5 cents per pound more asked for electrolytic nickel. During the last five months of the year prices ranged between 45 and 50 cents for ordinary forms.

Production of Nickel in Canada	1911	1912	1913	1914	1915
	Tons*	Tons*	Tons	Tons*	Tons*
Ore mined	612,511	737,584	784,697	1,000,364	1,364,048
Ore smelted	610,834	725,065	823,403	947,053	1,272,283
Bessemer matte produced	32,607	41,925	47,150	46,396	67,703
Copper content of matte	8,966	11,116	12,938	14,448	19,608
Nickel " "	17,049	22,421	24,838	22,759	34,039
Spot value of matte	$4,945,592	$6,303,102	$7,076,945	$7,189,031	$10,352,344
	1911	1912	1913	1914	1915
Exports of nickel from Canada	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Nickel contained in matte, etc.—					
Exported to Great Britain	5,023,393	5,072,867	5,164,512	10,291,979	13,748,000
Exported to United States	27,596,578	39,148,993	44,224,119	36,015,642	52,662,400
Exported to other countries	....	....	70,386	220,706	....
	32,619,971	44,221,860	49,459,017	46,538,327	66,410,400

Imports of nickel into United States	1911	1912	1913	1914	1915(*a*)
Gross tons of ore and matte ..Tons	23,993	33,101	37,623	29,564	41,043
Nickel contents ....Lbs.	29,545,967	42,168,769	47,194,101	35,006,700	50,099,707
Exports of nickel from United States					
To France ....Lbs.	5,463,358	5,083,947	3,631,858	3,457,157	2,749,554
To Netherlands .... "	9,101,150	7,387,447	6,622,811	855,168	52,770
To United Kingdom .... "	7,196,259	8,191,364	8,221,640	10,836,369	13,570,574
To other countries .... "	3,338,819	5,152,258	10,096,779	12,446,458	8,130,687
Total .... "	25,099,586	25,815,016	29,173,088	27,595,152	24,503,585

* In tons of 2,000 lbs. (*a*) Eleven months only.

LEAD.

Although there was an increase of nearly 25 per cent in the production of lead the 1915 output has been exceeded in six of the past 15 years. The production of lead in 1914 was 45,377,065 pounds, which valued at 5·60 cents per pound, the average price of pig lead in Montreal for the year, would be worth $2,541,116. The production in 1914 was 36,337,765 pounds valued at $1,627,568, or an average of 4·479 cents per pound. The 1915 production consists chiefly of pig and manufactured lead produced at Trail, B.C., but includes also an estimate of the lead probably recoverable from ores shipped to smelters outside of Canada. The entire output of the Surprise mine in the Slocan District, B.C., was shipped to the United States, refined in bond, and sold in London.

The exports of lead in ore, etc., in 1915 are recorded by the Customs Department as 1,845,100 pounds valued at $40,273, and of pig lead 2,066,929 pounds valued at $79,067. Exports in 1914 were 246,100 pounds of lead in ore and 510,573 pounds of pig lead.

The total value of the imports of lead and lead products in 1915 was $2,479,261 as against $1,042,538 in 1914. The 1915 imports included 42,616,200 pounds valued at $2,010,006, manufactured lead 3,102,838 pounds valued at $184,581, other manufactures valued at $102,439, litharge 1,579,800 pounds valued at $89,232 and lead pigments 1,709,035 pounds valued at $93,003. The imports of litharge and pigments would contain approximately 1,565 tons of metallic

lead and the total import of lead would therefore exceed 24,425 tons as shown by this record. The imports in 1914 were equivalent to about 10,869 tons.

The average monthly price of lead in Montreal varied between a minimum of 4·27 cents in January and a maximum of 6·61 cents in December, averaging for the year 5·60 cents. This is the producer's price for lead in car lots as per quotations kindly furnished by Messrs. Thos. Robertson and Co.

The average monthly price of lead in New York was 4·628 cents and in London £22·917 per gross ton, equivalent to 4·979 cents per pound.

ZINC.

Complete returns of zinc shipments have not yet been received but the tonnage is estimated at 15,553 tons containing 12,400,000 pounds of zinc. Shipments include several hundred tons from Notre Dame des Anges, Quebec, but the greater part is from some fifteen properties in British Columbia. Zinc shipments in 1914 were reported as 10,893 tons containing 9,101,460 pounds of zinc.

The Consolidated Mining and Smelting Company at Trail, B.C., after successful experimental development has installed at Trail a zinc recovery plant, having an initial daily capacity of 35 tons of refined zinc, and has entered into a contract with the Shell Committee for a considerable tonnage of zinc to be delivered during 1916. A small quantity of zinc was recovered during 1915 in connexion with the experimental work.

The Electro Zinc Company has constructed a plant at Welland, Ontario, for the recovery of refined zinc from zinc oxide. It is intended, eventually, to treat the zinc ores from Notre Dame des Anges, Quebec, at this plant.

At Silverton, B.C., a demonstrating plant, using the French process for the recovery of zinc, was operated during 1915 and satisfactory results are claimed.

In August the Dominion Government made an announcement with respect to a proposed bounty on zinc as follows:—

"Bounties on a sliding scale not exceeding two cents per pound will be granted upon production in Canada from Canadian ores of zinc containing not more than 2 per cent impurities when the standard price of zinc in London, England, falls below £33 per ton of 2,000 pounds, provided that bounties shall not be payable on zinc produced before the expiration of the war or after the 31st day of July, 1917, or on zinc contracted for by the Shell Committee at a price of 8 cents or over per pound. Total amount of bounty to be paid not to exceed $400,000."

The price of spelter in New York varied between a minimum of 5¾ cents per pound in January and a maximum of 25 to 27 cents in June, the price at the close of the year being from 15¼ to 16¾ cents and the average for the year 13·230 cents per pound.

The price of high-grade spelter rose from 10 cents at the beginning of the year to over 40 cents in midsummer and was maintained fairly strongly through the balance of the year at from 35 to 40 cents.

OTHER METALS.

Antimony: After several years of no production the demand and high price in 1915 caused a renewal of activity in mining antimony ores at West Gore, Nova Scotia, and Lake George, New Brunswick. About 1,288 tons of concentrates were shipped to England from the former locality. The antimony smelter at Lake George was operated toward the end of the year with a small production of refined antimony, and there was also some recovery of refined antimony at the lead refinery at Trail, B.C. Antimony ores are also reported to

have been shipped from Carpenter Creek, Slocan, from Bridge River District, Lillooet, B.C., and from the Yukon but no record has been obtained. The total production reported is estimated at about 961,040 pounds of antimony refined and in concentrates.

The recorded exports of antimony ore in 1915 were 1,149 tons valued at \$82,990, while the imports included antimony or regulus of, etc., 1,962,194 pounds valued at \$344,918 and antimony salts 67,956 pounds valued at \$10,320.

The price of antimony, ordinary grades, in New York ranged between a minimum of 13 cents in January to a maximum of 42 cents in December, averaging about 30 cents for the year. The price of "Cooksons" in December was 55 cents per pound and the year's average 40 cents.

Cobalt: Metallic cobalt is now being recovered as well as cobalt oxide at the smelters at Deloro and Thorold. The silver-cobalt-nickel ores of the Cobalt district are reduced in these smelters, silver being the principal product with arsenious oxide, metallic cobalt and nickel, cobalt oxide and nickel oxide as by-products. Returns received show a production in 1915 of 211,610 pounds of metallic cobalt and 379,219 pounds of cobalt oxide, equivalent to a total of 477,063 pounds of metal. In 1914 the production was reported as 899,027 pounds of cobalt oxide and 242,572 pounds of cobalt contained in residues sold outside of Canada or equivalent to a total of 871,891 pounds of cobalt. The price of cobalt is seldom quoted in the Mining Journals. However, a price of \$2 per pound 97% cobalt metal was recorded by the Engineering and Mining Journal in September and November.

Molybdenum: A production has been reported of about 28,600 pounds of molybdenite valued at \$28,460, including cobbed molybdenite and molybdenite contained in ore shipped to concentration plants. There were also about 50 tons of low grade ore sent to the Mines Branch ore testing laboratories for experimental concentration. The export of molybdenite was prohibited to other than British destinations except under license and from September 23rd the British Government requisitioned all molybdenite arriving in the United Kingdom at a price of 105 shillings per unit of MoS_2 C.I.F. Liverpool and appointed Messrs. H. A. Watson and Co., Liverpool, as buyers.

Platinum: Efforts are being continued to recover platinum from the gravels on the Tulameen river in the Similkameen district of British Columbia and there is also occasional recovery of small quantities from the gold gravels of Quesnel division, Cariboo district. A recovery of about 20 ounces is reported in 1915. There was no recovery of platinum from the Sudbury nickel-copper mattes.

Customs records show an export of platinum of 236 ounces valued at \$11,052, but this may possibly include old metal.

The price of refined platinum in New York which was about \$41 per ounce in January fell to \$38 in June and July, but increased to an average of \$85.50 in December. The year's average was about \$47.

IRON ORE.

Iron ore shipments in 1915 amounted to 398,112 short tons valued at \$774,427 as compared with 1914 shipments of 244,854 short tons valued at \$542,041. The 1915 shipments included hematite 205,989 tons, roasted siderite 132,906 tons, and cobbed magnetite and concentrates 59,217 tons. The 1914 shipments included hematite 89,454 tons, roasted siderite 109,838 tons, and cobbed magnetite and concentrates 45,562 tons.

In the Great Lakes area the same ore prices prevailed as in 1914 and 1910 which were the lowest recorded in many years.

Mine operators report 93,444 tons of ore exported to the United States and 304,668 tons shipped to Canadian furnaces.

According to the records of the Customs Department exports of iron ore amounted to 79,770 tons valued at $206,823 and imports of iron ore to 1,499,722 tons valued at $2,320,066.

Shipments of iron ore from Wabana Mines, Newfoundland, in 1915, by the two Canadian companies operating there were 868,451 short tons of which 802,128 tons were shipped to Cape Breton and 66,323 tons to England. In 1914 the shipments were 639,430 short tons of which 422,920 tons went to Cape Breton and 216,510 to the United States and Europe.

PIG-IRON.

The total production of pig-iron in Canadian blast furnaces in 1915 was 913,719 short tons, valued at approximately $11,592,819 as compared with a production of 783,164 short tons in 1914 valued at approximately $10,002,856. A large proportion of this production is used directly in the manufacture of steel and the values are in part estimated. The 1915 output shows an increase of 130,555 tons or 16·67 per cent over that of 1914, and compares favourably with the average of recent years.

Of the total production in 1915, 13,692 tons were made with charcoal and 900,027 tons with coke.

Included in the ore charged to blast furnaces there was 293,305 short tons from Canadian mines and 1,463,681 tons of imported ore. Of the imported ore approximately 840,587 tons came from Newfoundland.

The blast furnace plants, operated for varying periods of time, included those of the Dominion Iron and Steel Company at Sydney, N.S., the Nova Scotia Steel and Coal Company at North Sydney, N.S., the Standard Iron Company at Deseronto, Ontario, the Steel Company of Canada at Hamilton, Ontario, the Canadian Furnace Company at Port Colborne, Ontario, and the Algoma Steel Company at Sault St. Marie, Ontario.

The production of pig-iron by provinces in 1914 and 1915 was as follows:—

	1914			1915		
	Tons	Value	Value per Ton	Tons	Value	Value per Ton
		$	$		$	$
Nova Scotia..........	227,052	2,951,676	13.00	420,219	5,462,847	13.00
Ontario...............	556,112	7,051,180	12.68	493,500	6,129,972	12.42
	783,164	10,002,856	12.77	913,719	11,592,819	12.69

There was also in 1915 a production in electric furnaces of 10,794 tons of ferro-alloys (chiefly ferro-silicon with a very small tonnage of ferro-phosphorus) valued at $753,406 as compared with a production in 1914 of 7,524 tons valued at $478,355. About two-thirds of the ferro-silicon production in 1915 was of 50 per cent grade, and the balance was of 75 and 85 per cent grade.

The exports during 1915 of pig iron were 17,307 short tons valued at $231,551 or an average per ton of $13.38, and of ferro-silicon and ferro-compounds 9,238 tons valued at $537,081, an average of $50.81 per ton, or a total of 26,545 tons valued at $768,632 as compared with a total in 1914 of 19,063 tons valued at $486,366. The imports were 47,482 tons of pig iron valued at $624,200, or an

average of $13.15 per ton, and 13,758 tons of speigeleisen, ferro-manganese and ferro-silicon valued at $807,312, or a total of 61,240 tons valued at $1,431,512.

Electro Metals, Ltd., producing ferro-silicon, have considerably enlarged the capacity of their plant at Welland, Ontario, to meet the increased demand for their product occasioned by the war. In addition to sales for Canadian consumption a large and important tonnage has been furnished to Great Britain, Russia and the United States.

STEEL INGOTS AND CASTINGS.

The production of steel ingots and castings in 1915 including 5,626 tons from electric furnaces, was 1,020,335 short tons, as compared with a production in 1914 of 828,641 tons. The 1914 production included open-hearth ingots 608,383 tons; bessemer ingots 203,184 tons; direct open-hearth castings 15,315 tons; and other steel castings 1,759 tons, these figures being a revision of those previously published.

ASBESTOS.

The asbestos production in 1915 was obtained from the same field in Quebec as heretofore. The output was less than in 1914, but sales showed an increase of about 17 per cent. Stocks on hand at the end of the year showed a noticeable decrease.

The total output in 1915 was 106,558 tons, as against 107,668 tons in 1914, showing a decrease of 1,110 tons or 1·03 per cent. The sales and shipments during 1915 were 113,115 tons valued at $3,491,450, or an average of $30.87 per ton, as against sales in 1914 of 96,542 tons valued at $2,892,266 or an average of $29.92 per ton. The 1915 sales were larger in quantity than those of 1914 by about 17 per cent and in value by about 20 per cent.

Stocks on hand at December 31st, 1915, were 22,052 tons, as compared with stocks on hand of 31,171 at the end of the previous year.

The number of men employed in the mines or quarries and mills were 2,393 and the amount paid in wages was $1,089,976 as against 2,992 men employed in 1914 to whom was paid in wages $1,283,977.

The total quantity of asbestos rock milled during the year is reported as 1,795,472 tons, which with a mill production of 102,571 tons shows an average estimated content of about 5·71 per cent of asbestos fibre in the rock. The estimated content of fibre in rock milled in 1914 was 6·03 per cent.

The output and sales of crude and mill stock are shown separately for 1914 and 1915 in the tables following. The classification is based on valuation: Crude No. 1 comprising material valued at $200 per ton and upwards, and Crude No. 2 material valued at less than $200 per ton; Mill stock No. 1 including mill fibre valued at $30 and upwards, Mill stock No. 2, mill fibre valued at $15 to $30 per ton, and Mill stock No. 3 mill fibre valued at less than $15 per ton.

Output Sales and Stocks in 1915.

	Output	Sales			Stock on hand, Dec. 31		
	Tons	Tons	Value	Per ton	Tons	Value	Per ton
			$	$		$	$
Crude No. 1.......	2,305·6	2,735·4	749,811	274.11	589·8	176,533	299.31
" 2.......	1,681·6	2,631·3	322,049	122.39	316·6	43,006	135.84
Mill stock No. 1...	21,710	24,238	1,270,074	52.40	2,176	91,919	42.24
" 2...	41,973	42,031	840,132	19.99	12,837	268,197	20.89
" 3...	38,888	41,479	309,384	7.46	6,133	55,555	9.06
Asbestos..........	106,558·2	113,114·7	3,491,450	30.87	22,052·4	635,210	28.80
Asbestic..........	....	25,700	21,819	0.85	....	....	....

Output Sales and Stocks in 1914.

	Output	Sales			Stock on hand Dec. 31		
	Tons	Tons	Value	Per ton	Tons	Value	Per ton
			$	$		$	$
Crude No. 1.......	1,450·6	1,335·9	402,417	301.23	984·3	301,237	306.04
" 2.......	2,611	2,812	370,776	131.87	1,411	187,338	132.78
Mill stock No. 1...	16,144	19,388	932,893	48.12	4,616	229,361	49.69
" 2...	58,362	47,851	963,973	20.15	15,114	305,809	20.23
" 3...	29,101	25,155	222,207	8.83	9,046	76,522	8.46
Asbestos..........	107,668·6	96,541·9	2,892,266	29.96	31,171.3	1,100,267	35.30
Asbestic..........	....	21,031	17,540	0.83	....	....	....

The total sales of crude asbestos in 1915 were 5,366·7 tons valued at $1,071,-860 or an average of $199.72 per ton as against sales in 1914 of 4,147·9 tons valued at $773,193 or an average of $186.42 per ton.

The total sales of mill stock in 1915 were 107,748 tons valued at $2,419,590 or an average of $22.46 per ton, as against sales in 1914 of 92,394 tons valued at $2,119,073, or an average of $21.64 per ton.

There was also a production of asbestic of 25,700 tons valued at $21,819.

Exports of asbestos during the calendar year 1915 were 84,584 tons valued at $2,734,695 or an average of $32.45 per ton, as against exports of 81,081 tons in 1914 valued at $2,298,646 or an average of $28.35 per ton. There was also an export of asbestos sand amounting to 25,103 tons valued at $157,410 or an average of $6.27 per ton and of manufactures of asbestos valued at $125,003.

Imports of asbestos manufactures for the year amounted to $168,894.

CHROMITE.

From 1910 to 1914 inclusive no chromite was mined in Canada, and only a few small shipments were made from stock; but in 1915, according to returns received, shipments amounted to 11,486 tons,[1] valued at $162,618.

[1] Further returns received would appear to show total shipments of 14,291 tons valued at $208,718. However, the railway shipments from Coleraine, Black Lake, Thetford Mines and Robertson have been reported as 11,332 tons, and in view of the considerable local buying and selling there may be a possibility of duplication in production records

In the early summer the demand for chromite in the United States led to considerable activity in the chromite-producing area in the vicinity of Black Lake and Coleraine, Quebec. Old dumps were picked over, and old pits re-opened. During the summer months ore averaging probably less than 30 per cent Cr_2O_3 found a ready market, but towards the close of the year buyers were insisting on a 35 per cent ore.

The exports of chromite according to Customs records were 7,290 tons valued at $81,838 or an average of $11.23 per ton.

COAL AND COKE.

Coal: The total production of marketable coal for the year 1915 (comprising sales and shipments, colliery consumption, and coal used in making coke, or used otherwise by colliery operators), was 13,209,371 short tons valued at $31,957,757, as against 13,637,529 tons valued at $33,471,801 in 1914 showing a decrease of 428,158 tons, or 3·14 per cent in quantity, and of $1,514,044 or 4·52 per cent in total value.

In estimating the values of the coals arbitrary values are assumed for the Nova Scotia and British Columbia production viz.: $2.50 per long ton for the former and $3.50 per long ton for the latter. The values used for coal production in the other provinces are those furnished by the operators.

The Nova Scotia production was 7,429,888 tons, an increase of 58,964 tons, or 0·8 per cent over that of 1914; the Alberta[1] production 3,320,431 tons, a decrease of 362,584 tons, of 9·8 per cent; the British Columbia production 2,089,966 tons, a decrease of 149,833 tons, or 6·7 per cent; the Saskatchewan production 236,940 tons, an increase of 4,641 tons, or about 2 per cent; the New Brunswick production 122,422 tons, an increase of 24,373 tons, or 24·85 per cent; and Yukon Territory, a production of 9,724 tons, a decrease of 3,719, or 28 per cent.

Province	1913		1914		1915	
	Tons	Value $	Tons	Value $	Tons	Value $
Nova Scotia	7,980,073	17,812,663	7,370,924	16,452,955	7,429,888	16,584,573
British Columbia	2,714,420	8,482,562	2,239,799	6,999,374	2,089,966	6,531,144
Alberta	4,014,755	10,418,941	3,683,015	9,350,392	3,320,431	8,136,527
Saskatchewan	212,897	358,192	232,299	374,245	236,940	361,787
New Brunswick	70,311	166,637	98,049	241,075	* 122,422	304,830
Yukon	19,722	95,945	13,443	53,760	9,724	38,896
Total	15,012,178	37,334,940	13,637,529	33,471,801	13,209,371	31,957,757

* Railway shipments.

The exports of coal in 1915 were 1,766,543 tons valued at $5,406,058 as compared with exports of 1,423,126 tons in 1914 valued at $3,880,175, an increase of 343,417 tons or 2·41 per cent.

The imports of coal in 1915 were made up as follows: bituminous, round and run of mine, 6,106,794 tons, valued at $7,564,369, or an average of $1.24 per ton; bituminous slack, 2,286,916 tons valued at $2,027,256, or an average of $0.89 per ton, and anthracite 4,072,192 tons valued at $18,753,980 or an average of $4.61 per ton, making a total of 12,465,902 tons valued at $28,345,605.

[1] Mr. Stirling, Chief Inspector of Mines, advises on February 26, that the 1915 output in Alberta, excluding unmarketable slack, was 3,299,969 tons.

Imports during 1914 included bituminous, round and run of mine 7,776,415 tons valued at $14,954,321 or an average of $1.92 per ton, bituminous slack 2,509,632 tons valued at $3,605,253 or an average of $1.43 per ton, and anthracite 4,435,010 tons valued at $21,241,924 or an average of $4.79 per ton, making total imports of 14,721,057 tons valued at $39,801,498.

The above figures show that in 1915 there was a decrease from imports of the previous year in quantity of 2,255,155 tons, or 15·3 per cent, and in value of $11,455,893, or 28·78 per cent. The larger decrease in value is due to the average value of bituminous, round, and run of mine dropping from $1.92 per ton in 1914 to $1.24 per ton in 1915, and that of bituminous slack from $1.44 to $0.89.

The details of the decreases in imports are as follows: in bituminous, round and run of mine 1,669,621 tons or 21·5 per cent; in bituminous slack of 222,716 tons, or 8·9 per cent; and in anthracite of 362,818 tons or 8·2 per cent.

The apparent consumption of coal during 1915 was therefore 23,849,040 tons, as against a consumption the previous year of 26,852,323 tons. Canadian mines contributed 48 per cent of the domestic consumption, and the balance was imported. The total Canadian production was equivalent to about 53·4 per cent of the consumption.

Coke: The total output of oven coke during 1915 was 1,200,766 short tons made from 1,856,393 tons of coal of which 1,425,172 tons were of domestic origin, and 431,221 tons were imported. The total quantity of coke sold, or used by the producers during the year was 1,168,921 tons valued at $4,253,536 or an average of $3.64 per ton.

In 1914 the total output was 1,015,253 tons, and the quantity sold, or used by the producers, was 1,023,860 tons valued at $3,658,514 or an average of $3.57 per ton.

Returns for 1915 show a production of 0·647 tons of coke per ton of coal charged, as compared with 0·658 tons of coke per ton of coal charged in 1914.

The output of coke by provinces in 1915 was as follows: Nova Scotia 584,993 tons, an increase of 239,113 tons over 1914 production; Ontario 316,211 tons, a decrease of 61,303 tons; Alberta 24,187 tons, a decrease of 4,354 tons; and British Columbia 275,375 tons, an increase of 12,057 tons. The Ontario production was entirely from imported coal.

By-products from coke ovens which included 10,448 tons of ammonium sulphate, 7,365,931 gallons of tar, and 4,089,602 thousand cubic feet of gas, made in 1915 were in excess of the production in 1914; there was also for the first time a production of benzol and associated compounds. The production of trinitrotoluene near the close of the year was reported[1] by Col. Carnegie of the Shell Committee, as 100,000 pounds per week.

The ovens operated during the year were those at Sydney, Sydney Mines and Westville, Nova Scotia, Sault Ste. Marie, Ontario, Coleman, Alberta, and Fernie, Michel, and Union Bay (Comox), British Columbia. At the close of the year there were about 1,742 ovens in operation, as contrasted with only 797 in operation at the end of 1914. Over 800 ovens at Stellarton and Londonderry in Nova Scotia, Port Arthur, Ontario, Lille and Passburg, Alberta, Carbonado and Hosmer, British Columbia, were idle throughout the year.

Imports of coke during 1915 amounted to 637,857 tons valued at $1,608,464, and exports were 35,869 tons valued at $160,053.

FELDSPAR.

The 1915 production of feldspar was 15,455 tons, valued at $59,124 or an average of $3.18 per ton as compared with a production in 1914 of 18,060 tons valued at $70,824 or an average of $3.92 per ton. The year's production is

[1] Bulletin Can. Mining Institute, December, 1915, p. 902.

slightly less than the average of the preceding six years. As usual by far the greater proportion of the production came from Frontenac county, Ontario. It is of interest to note however that there has been a renewal of feldspar mining in Hull township, Quebec.

FLUORSPAR.

Fluorspar is obtained at Madoc, Ontario. There have been no shipments for three years, but the operators report having contracted for delivery of 1,000 tons in 1916.

Imports of fluorspar are not shown separately in the Customs records; imports of hydro-fluo-silicic acid in 1915 were 1,117,874 pounds valued at $36,085.

GRAPHITE.

Shipments of milled and refined graphite amounted to 2,610 tons valued at $121,023 or an average of $46.37 per ton. This includes 76 tons from mills at Buckingham, Que. The major portion of the production came from Calabogie, Renfrew county, Ont., with a small tonnage from Mumfords, Hastings county. The production includes material varying in value from less than $40 to over $150 per ton. The 1914 production was 1,647 tons valued at $107,203. Operators report a greatly increased demand with higher prices owing to the shortage in supplies in the United States from sources outside of America.

Exports of plumbago and of manufactures of plumbago were valued at $96,-325 according to Customs records.

GYPSUM.

The production of gypsum of all grades in 1915 s reported as 470,335 tons valued at $849,928. This is lower than for several years, previous production having been 516,880 tons in 1914; 636,370 tons in 1913; and 578,454 tons in 1912. The Ontario production was practically the same as in 1914, while New Brunswick production showed a slight increase. In both Manitoba and Nova Scotia 1915 production showed a conspicuous decrease from that of the previous year.

Gypsum sold in 1915 was classified as follows: lump 342,467 tons; crushed 48,735 tons; fine ground 6,455 tons; and calcined 72,678 tons. In 1914 the tonnages of the various grades were: lump 351,729 tons; crushed 49,441 tons; fine ground 6,097 tons; and calcined 109,613 tons.

Exports of crude gypsum were 292,234 tons valued at $336,380 being the smallest reported since 1908. Exports of ground gypsum which were valued at less than $10,000 yearly for many years rose to a value of $35,490 in 1914 and to a value of $80,933 in 1915.

MAGNESITE.

The production of magnesite in 1915, chiefly crude but including some calcined, was 14,779 tons valued at $126,535 in contrast with a yearly average production from 1908 to 1914 inclusive of $621\frac{1}{2}$ tons. The increased production was due largely to the urgent demands of steel companies and manufacturers of refractory brick.

All the production came from Grenville township, Argenteuil county, Quebec. From the Atlin district in British Columbia several hundred tons were shipped to Vancouver, but not marketed.

MANGANESE ORES.

In 1915 there was according to returns received to date, a production of 47 tons of manganese ore (90% MnO_2) valued at $5,460 or an average of $116.17

per ton, as compared with a production in 1914 of 28 tons, valued at $1,120 or an average of $40 per ton.

The records of the Customs Department show exports of manganese ores amounting to 255 tons, valued at $6,855, which would seem to indicate shipments additional to those reported.

The property at New Ross, Nova Scotia, formerly operated by the Nova Scotia Manganese Company was taken over in September and re-opened by the Metals Development Company of Halifax.

NATURAL GAS.

Complete returns have not yet been received from some of the largest operators in Ontario. The 1915 production of natural gas therefore (subject to the corrections of the estimates used) was approximately 18,319,710 thousand cubic feet valued at $3,300,825 contributed by provinces as follows: Ontario 13,510,071 thousand cubic feet valued at $2,202,523; New Brunswick 430,692 thousand cubic feet valued at $60,383, and Alberta 4,378,947 thousand cubic feet valued at $1,037,919.

The production the previous year was reported as 21,692,504 thousand cubic feet valued at $3,484,727 of which amount Ontario produced 14,094,521 thousand cubic feet valued at $2,215,808; New Brunswick 425,826 thousand cubic feet valued at $54,249, and Alberta 7,172,157 thousand cubic feet valued at $1,214,670.

Ontario's production in 1915 showed a decrease of 584,450 thousand cubic feet, Alberta production a decrease of 2,793,210 thousand cubic feet, and New Brunswick production an increase of 4,866 thousand cubic feet.

The Ontario gas production came from the same fields in the southern portion of the province between Niagara Falls and Windsor, as heretofore. In 1914 and 1915 gas from the Kent fields was distributed as far east as Hamilton, a distance of 153 miles.

The New Brunswick production is obtained in Albert county and supplies chiefly Hillsborough and Moncton, while in Alberta, Medicine Hat and Bow Island are still the principal gas fields being utilized, supplying the district between Medicine Hat and Calgary.

PETROLEUM.

The annual production of crude petroleum which had been showing a steady decrease from 1907 to 1914 showed in 1915 a slight increase in quantity over the 1914 production. The value, though, was the lowest recorded in the records of the Division which date back to 1885 for the average price per barrel in Western Ontario (from which nearly the entire Canadian production comes) was the lowest in several years.

A bounty of 1½ cent per gallon is paid on the marketed production of crude oil from Canadian oil-fields through the Department of Trade and Commerce. From the bounty statistics it appears that the 1915 production in Ontario and New Brunswick was 215,464 barrels on which bounties amounting to $113,118.45 were paid. The market value of this crude oil at $1.39½ per barrel amounted to $300,572. In Alberta there was a small production of crude oil; but no bounty was paid on this as the specific gravity was below the standard set by the Petroleum Bounty Act, and complete records have not been furnished by the producers.

The total production of crude oil (exclusive of Alberta) in 1915 is therefore 215,464 barrels, valued at $300,572 as compared with a production in 1914 of 214,805 barrels valued at $343,124.

The average monthly price of crude oil per barrel at Petrolia for the year was $1.39½ as compared with $1.59 in 1914, and $1·782 in 1913. For the first

seven months of the year the average price was almost constant at $1.30½ per barrel but during the last five months it showed an increase month by month reaching a maximum of $1.70 in December.

The Ontario production in 1915 was, according to the records of the Department of Trade and Commerce at Ottawa, 214,444 barrels. The production in barrels of the various fields, as furnished by the Supervisor of Petroleum Bounties at Petrolia, was as follows: Lambton 161,368; Tilbury 12,742; Bothwell 33,395; Dutton 5,401; Onondaga 1,490, and Belle River 46; giving a total of 214,442 barrels. In 1914 the production by fields was as follows: Lambton 154,186; Tilbury 18,530; Bothwell 33,961; Dutton 2,190; Onondaga 2,437; and Belle River 1,191; giving a total of 212,495 barrels.

The production in New Brunswick was 1,020 barrels as against 1,725 in 1914 and 2,111 in 1913.

Exports of petroleum entered as crude mineral oil in 1915 were 35,977 gals. valued at $1,789, and of refined oil 103,488 gals. valued at $14,107. There was also an export of naphtha and gasoline of 16,644 gals. valued at $4,540.

The total value of the imports of petroleum and petroleum products in 1915 was $8,047,781 as against a value of $11,174,763 in 1914.

The total imports of petroleum oils, crude and refined, in 1915 were 236,923,765 gals. valued at $7,979,264. The oil imports included, crude oil 192,588,487 gals. valued at $3,678,021, refined and illuminating oils, 6,792,873 gals., valued at $405,019; gasoline 28,030,972 gals. valued at $2,693,717, lubricating oils 4,557,179 gals. valued at $755,535, and other oils, products of petroleum 4,954,254 gals. valued at $446,972. The oil imports in 1914 were: crude oil 195,207,210 gals. valued at $5,750,971; refined and illuminating oils 12,833,065 gals. valued at $970,481; gasoline 24,396,041 gals. valued at $2,747,360; lubricating oils 5,767,676 gals. valued at $940,143 and other oils, products of petroleum 6,283,621 gals. valued at $663,407, making a total of 244,487,973 gals. valued at $11,072,362.

The imports of petroleum products in 1915 included 980,662 pounds of paraffin and paraffin wax candles valued at $68,517, as compared with imports in 1914 of 1,594,236 pounds valued at $102,401.

PYRITES.

The production of pyrites in 1915 was 296,910 tons valued at $1,028,678 of which 153,607 tons valued at $614,428 was mined in Quebec, and 143,303 tons valued at $414,250 was mined in Ontario. The 1914 production was 228,314 tons valued at $744,508 of which 117,698 tons valued at $470,792 came from Quebec and 110,616 tons valued at $273,716 came from Ontario.

Exports of pyrites in 1915 were 137,598 tons valued at $527,318, or an average of $3.83 per ton, as compared with exports in 1914 of 89,888 tons valued at $377,985, or an average of $4.21 per ton.

Exports of sulphuric acid in 1915 amounted to 19,270,572 pounds valued at $243,457, as against exports in 1914 of 7,485,509 pounds valued at $45,612.

SALT.

The total sales of salt in 1915 were 119,900 tons, valued at $600,226 (exclusive of the cost of packages) as compared with sales in 1914 of 107,038 tons, valued at $493,648. The entire Canadian production of recent years has come from southwestern Ontario.

The Canadian Salt Co. in addition to selling salt, uses a portion of its production in its chemical works at Sandwich, Ontario, where caustic soda and bleaching powder are manufactured.

The exports of salt were 889,300 pounds, valued at $5,836, as compared with exports in 1914 of 952,700 pounds, valued at $5,229.

The total imports of salt in 1914 were 137,486 tons valued at $517,526 and included 27,613 tons of fine salt in bulk, valued at $84,449; 6,867 tons of salt in packages, valued at $50,997, and 103,006 tons of salt imported for the use of fisheries, valued at $382,080. The imports in 1914 were 142,646 tons, valued at $540,881, including 26,065 tons of fine salt in bulk valued at $82,149; 7,828 tons of salt in packages, valued at $68,959; and 108,753 tons of salt for the use of sea or gulf fisheries, valued at $389,773.

TALC.

The production of talc was about the same as in the two preceding years the 1915 shipments being 11,885 tons, valued at $40,554.

The output of talc, all of which comes from the vicinity of Madoc, Ontario, is marketed in both crude and ground form in the United States and Canada.

CEMENT.

The general decrease in production of structural materials and clay products which was a feature in 1914 was repeated in 1915, the production in the latter year being valued at $18,712,074, as against a production in 1914 valued at $26,009,227.

The total quantity of Portland cement, including natural Portland, made in 1915 was 5,153,763 barrels of 350 pounds each, as compared with 8,727,269 barrels in 1914, a decrease of 3,563,506 barrels, or about 40 per cent.

The total quantity of Canadian Portland cement sold or used during 1915 was 5,681,032 barrels, valued at $6,977,024 or an average of $1·228 per barrel, as compared with 7,172,480 barrels, sold or used in 1914, valued at $9,187,924, or an average of $1.28, showing a decrease in quantity of 1,491,448 barrels, or about 20 per cent.

The total imports of cement in 1915 were 98,664 cwt. equivalent to 28,190 barrels of 350 pounds each, valued at $40,426, or an average of $1·434 per barrel, as compared with imports of 98,022 barrels, valued at $147,158, or an average of $1.50 per barrel in 1914.

The total consumption of cement, therefore, neglecting a small export, was 5,709,222 barrels, as compared with a consumption of 7,270,502 barrels in 1914, showing a decrease of 1,561,280 barrels, or about 21 per cent.

The average price per barrel at the works in 1915 was $1·228 as compared with $1.28 in 1914, $1.27 in 1913, $1.28 in 1912, and $1.34 during 1911 and 1910.

The imports of cement in 1915 included 1,065 barrels, valued at $1,480 from Great Britain, and 27,125 barrels, valued at $38,946, from the United States.

Production and Sales of Portland Cement.

	1912	1913	1914	1915
	Brls.	Brls.	Brls.	Brls.
Portland Cement sold or used	7,132,732	8,658,805	7,172,480	5,681,032
" manufactured	7,141,404	8,886,333	8,727,269	5,153,763
Stock on hand Jan. 1st	894,822	862,067	1,073,328	2,620,022
" Dec. 31st	903,094	1,089,595	2,628,117	2,062,961
Value of cement sold or used	$9,106,556	$11,019,418	$9,187,924	$6,977,024
Wages paid	$2,623,902	$3,466,451	$2,271,006	$1,180,882
Men employed	3,461	4,276	2,977	1,679

Consumption of Portland Cement.

Calendar Year	Canadian		Imported		Total
	Barrels	Per cent	Barrels	Per cent	Barrels
1911	5,692,915	90.0	661,916	10.0	6,354,831
1912	7,132,732	83.3	1,434,413	16.7	8,567,145
1913	8,658,805	97·1	254,093	2·9	8,912,988
1914	7,172,480	98·7	98,022	1·3	7,270,502
1915	5,681,032	99·5	28,190	0·5	5,709,222

Exports of Products of the Mine and Manufactures of Mine Products, Calendar Year 1915.

(Compiled from Trade and Navigation Statements).

Products		Quantity	Value
Arsenic	Cwt.	46,364	$ 174,190
Asbestos	Tons	84,584	2,734,695
Asbestos sand	"	25,103	157,410
Coal	"	1,766,543	5,406,058
Chromite	"	7,290	81,838
Feldspar, Magnesite, Talc, etc		....	148,915
Gold		....	16,528,143
Gypsum, crude	Tons	292,234	336,380
Copper, fine, in ore, etc	Lbs.	81,437,063	8,671,641
Copper, black, or coarse, and in pigs	"	21,292,516	3,788,715
Lead, in ore, etc	"	1,845,100	40,273
Lead, pig, etc	"	2,066,929	79,067
Nickel, in ore, etc	"	66,410,442	7,394,446
Platinum	Ozs.	236	11,052
Silver	"	27,672,481	13,812,038
Mica	Lbs.	879,631	236,124
Mineral Pigments	Cwt.	23,916	17,263
Mineral water	Gals.	198	53
Oil, mineral, crude	"	35,977	1,789
" " refined	"	103,488	14,107
Ores:—			
Antimony	Tons	1,149	82,990
Corundum	"	339	37,798
Iron	"	79,770	206,823
Manganese	"	255	6,855
Other ores	"	23,816	798,214
Phosphate	Tons	179	1,860
Plumbago, crude ore, etc	Cwt.	5,254	12,009
Pyrites	Tons	137,598	527,318
Salt	Cwt.	8,893	5,836
Sand and Gravel	Tons	808,022	380,549
Stone, ornamental	"	29,976	12,764
" building	"	35,804	28,910
" crushed	"	42,716	24,453
" for manufacture of grindstones	"	180	900
Other products of the mine	"	....	53,106
Total mine products		....	61,814,582
MANUFACTURES			
Agricultural implements:—			
Mowing machines	No.	5,031	175,912
Cultivators	"	5,957	166,602
Reapers	"	471	21,105
Drills	"	6,400	422,772
Harvesters and Binders	"	7,668	809,141
Ploughs	"	14,923	309,286
Harrows	"	4,459	81,731

Exports of Products of the Mine and Manufactures of Mine Products, Calendar Year 1915—*Continued.*

Products		Quantity	Value
Hay Rakes	No.	1,758	$ 40,289
Seeders	„	2	87
Threshing machines	„	1,001	568,401
All other			302,355
Parts of			519,379
Asbestos, manufactures of			125,003
Bricks	M.	1,155	9,089
Cement			5,161
Clay, manufactures of			25,202
Coke	Tons	35,869	160,053
Drugs:—			
Acetate of lime	Lbs.	10,001,830	205,748
Acid sulphuric	„	19,270,572	243,457
Calcium carbide	„	102,017,471	3,160,950
Phosphorus	„	545,050	77,476
Earthenware and all manufactures of			11,281
Fertilizers			2,335,297
Grindstones, manufactured			35,334
Gypsum or Plaster, ground			80,933
Iron and Steel, and manufactures of:—			
Stoves	No.	1,271	18,563
Gas buoys and parts of			2,017
Castings, N.O.P			143,714
Pig iron	Tons	17,307	231,551
Ferro-silicon and ferro-compounds	„	9,238	537,081
Wire and wire nails	Cwt.	1,439,950	3,224,740
Machinery:—			
Linotype machines and parts of			6,946
Sewing machines	No.	2,557	30,479
Washing machines	„		20,334
Typewriters	„	3,175	206,811
Machinery, N.O.P			536,162
Scrap iron and steel	Cwt.	1,787,155	883,134
Hardwaıe, viz.: tools, hand or machine			321,021
Hardware, N.O.P			401,053
All other, N.O.P			31,147,770
Lime			15,617
Metals:—			
Aluminium in bars, etc	Cwt.	186,808	3,333,726
„ manufactures of			620,562
Brass, old and scrap	Cwt.	120,685	1,468,165
Copper, old and scrap	„	41,616	616,553
Metallic shingles, etc			66,655
Metals, N.O.P			878,258
Mineral and aerated waters (in bottles)			3,525
Oil, gasoline and naphtha	Gals.	16,644	4,540
„ N.O.P	„	1,247,376	290,943
Plumbago, manufactures of			84,316
Stone, ornamental			5,990
„ building			660
Tar			37,331
Tin, manufactures of			173,206
Vehicles:—			
Automobiles	No.	13,475	6,756,395
„ parts of			363,178
Bicycles	No.	116	4,692
„ parts of			15,547
			62,343,279
Grand Total			124,157,861

Mineral Production in Canada 1914.

(Revised).

Product		Quantity (a)	Value (b)
METALLIC			$
Cobalt oxide	Lbs.	899,027	606,593
Nickel oxide	"	392,512	
Cobalt material, mixed cobalt and nickel oxides	"	2,079,001	79,995
Copper, value at 13·602c per lb	"	75,735,960	10,301,606
Gold	Ozs.	773,178	15,983,007
Iron, pig from Canadian ore (c)	Tons	95,744	1,138,912
" ore sold for export	"	60,410	135,300
Lead, value at 4·479c per lb	Lbs.	36,337,765	1,627,568
Molybdenum ore	Tons	16	2,063
Nickel, value at 30c per lb	Lbs.	45,517,937	13,655,381
Silver, value at 54·811c per oz	Ozs.	28,449,821	15,593,631
Zinc ore	Tons	10,893	262,563
Total		....	59,386,619
NON-METALLICS			
Actinolite	Tons	119	1,304
Arsenious oxide	"	1,737	104,015
Asbestos	"	96,542	2,892,266
Asbestic	"	21,031	17,540
Chromite	"	136	1,210
Coal	"	13,637,529	33,471,801
Corundum	"	548	72,176
Feldspar	"	18,060	70,824
Fluorspar	"	Nil.	....
Graphite,	"	1,647	107,203
" artificial	"	617	....
Grindstones	"	3,976	54,504
Gypsum	"	516,880	1,156,207
Magnesite	"	358	2,240
Manganese	"	28	1,120
Mica	"	....	109,061
Mineral Pigments:—			
Barytes	"	612	6,169
Ochres	"	5,890	51,725
Mineral water		....	134,111
Natural gas	M. cu. ft.	21,692,504	3,484,727
Peat	Tons	685	2,470
Petroleum (d)	Bbls.	214,805	343,124
Phosphate	Tons	954	7,275
Pyrites	"	228,314	744,508
Quartz	"	54,148	84,583
Salt	"	107,038	493,648
Talc	"	10,808	40,418
Tripolite	"	650	13,000
Total		....	43,467,229
Cement, Portland	Bbls.	7,172,480	9,187,924
Clay products:—			
Brick, common	No.	457,513,762	3,653,861
" pressed	"	93,634,858	1,115,556
" paving	"	2,707,000	49,627
" moulded and ornamental	"	1,554,496	23,592
Fireclay and fireclay products		....	107,568
Fireproofing and architectural terra-cotta		....	405,543
Kaolin	Tons	1,000	10,000
Pottery		....	35,371
Sewerpipe		....	1,104,499
Tile, drain		....	366,340

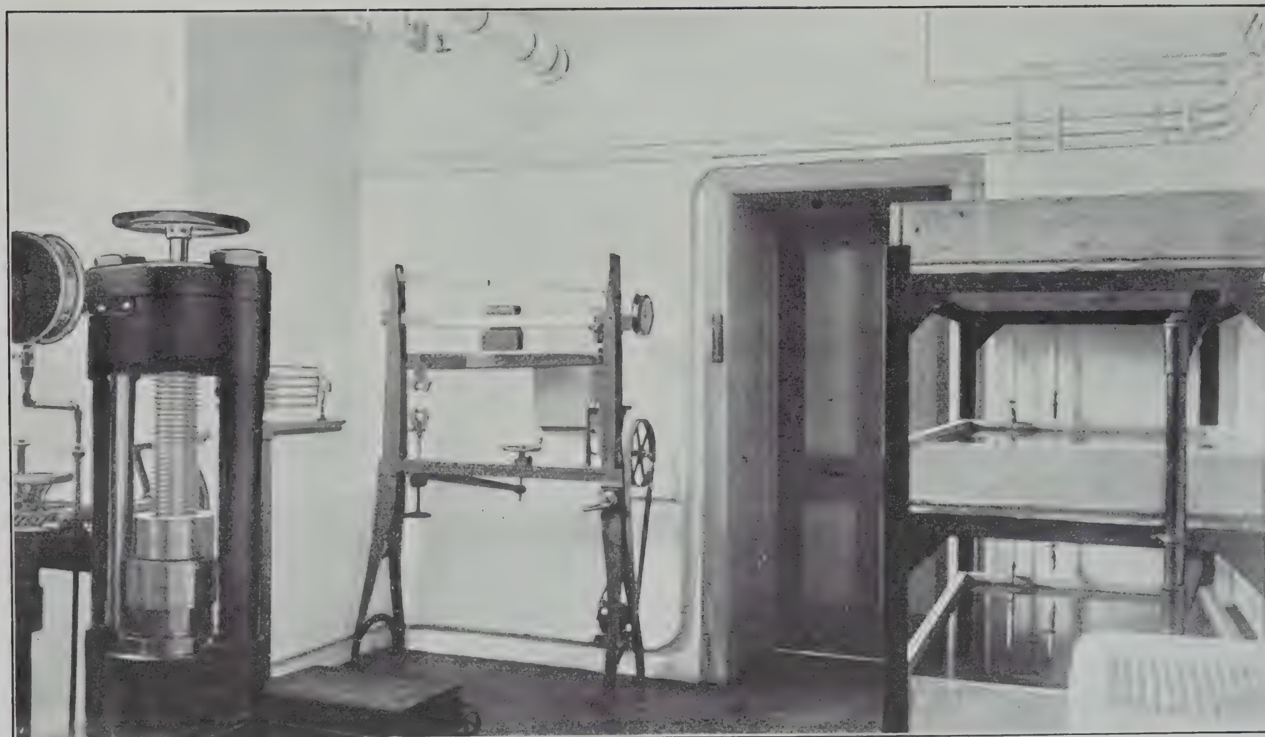
Mineral Production in Canada 1914—*Continued.*

Product		Quantity (*a*)	Value (*b*)
Lime	Bus.	7,028,582	1,360,628
Sand-lime brick	No.	70,650,030	609,515
Sand and gravel			2,505,310
Slate	Sq.	1,075	4,837
Stone:—			
Granite			2,176,602
Limestone			2,672,781
Marble			132,533
Sandstone			487,140
Total			26,009,227
Grand Total			128,863,075

(*a*) Quantity of product sold or shipped. Tons of 2,000 pounds.
(*b*) The metals, copper, lead and silver are for the purpose of these statistics valued at the prices of the metals as quoted in recognized markets. Nickel is valued at less than market price because a considerable portion of the output is marketed as monel metal and sold at a price less than that of nickel.
(*c*) The total production of pig iron in Canada in 1914 was 783,164 tons of which it is estimated 95,744 tons should be credited to Canadian ore and 687,420 tons to imported ore.
(*d*) Production based on claims made for bounty.

Annual Mineral Production in Canada Since 1886.

Year	Value of production	Value per capita	Year	Value of production	Value per capita
	$	$ cts'		$	$ cts.
1886	10,221,255	2.23	1901	65,797,911	12.16
1887	10,321,331	2.23	1902	63,231,836	11.36
1888	12,518,894	2.67	1903	61,740,513	10.83
1889	14,013,113	2.96	1904	60,082,771	10.27
1890	16,763,353	3.50	1905	69,078,999	11.49
1891	18,976,616	3.92	1906	79,286,697	12.81
1892	16,623,415	3.39	1907	86,865,202	13.75
1893	20,035,082	4.04	1908	85,557,101	13.16
1894	19,931,158	3.98	1909	91,831,441	13.70
1895	20,505,917	4.05	1910	106,823,623	14.93
1896	22,474,256	4.38	1911	103,220,994	14.42
1897	28,485,023	5.49	1912	135,048,296	18.27
1898	38,412,431	7.32	1913	145,634,812	18.77
1899	49,234,005	9.27	1914	128,863,075	15.96
1900	64,420,877	12.04	1915	138,513,750	....

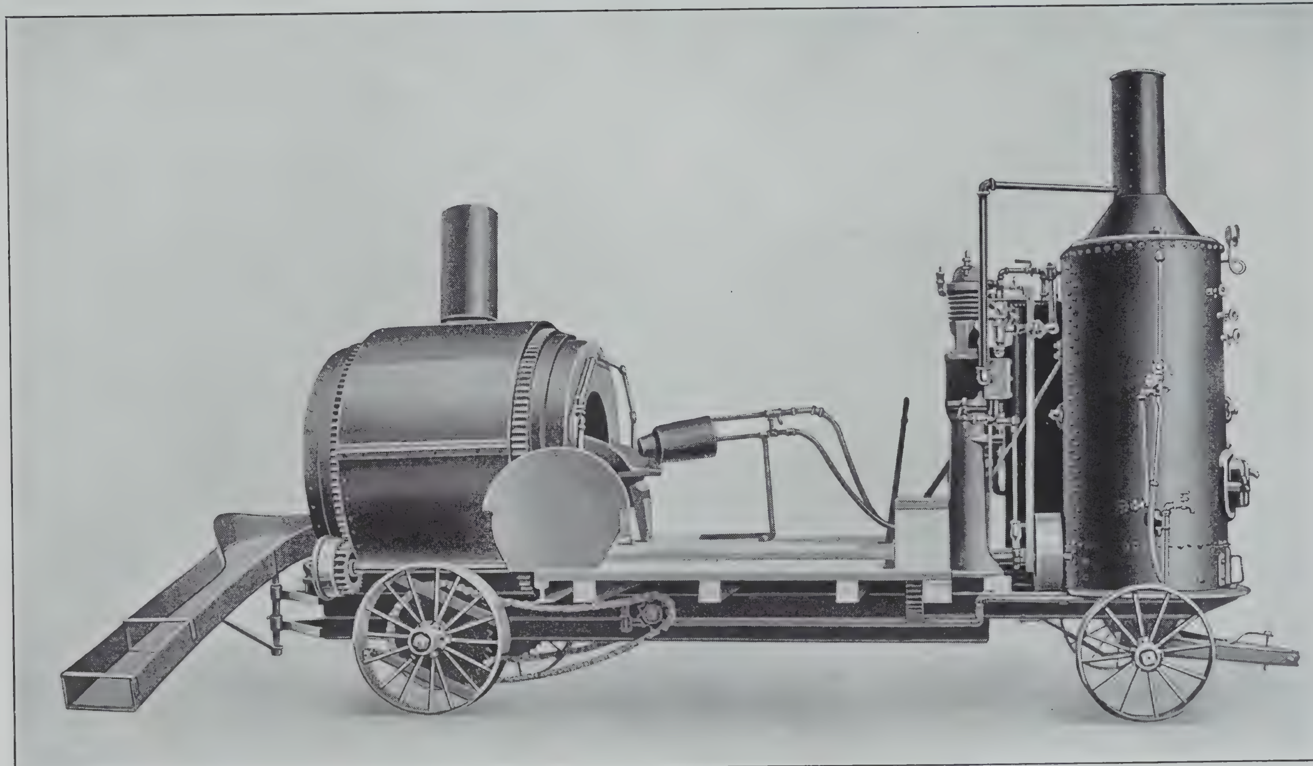


Structural materials laboratory: showing compression and tension machines.

PLATE II.

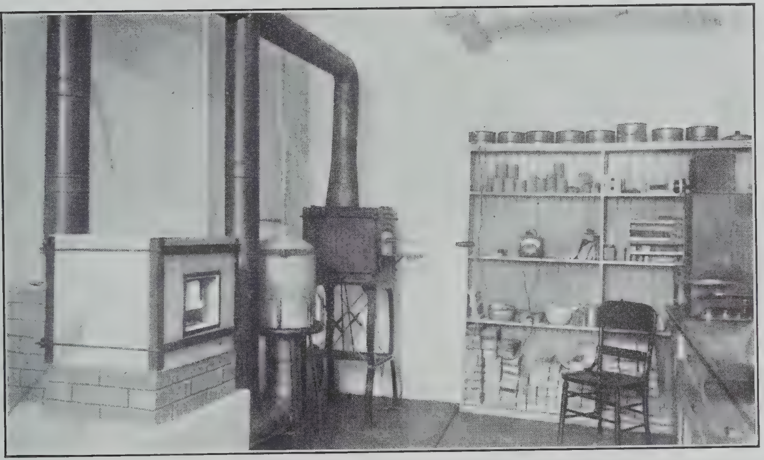
Structural materials laboratory: mixing table, sieve agitator, moist closet, and asphalt testing apparatus.

Experimental pavement laid with bituminous sands, Edmonton, Alberta.

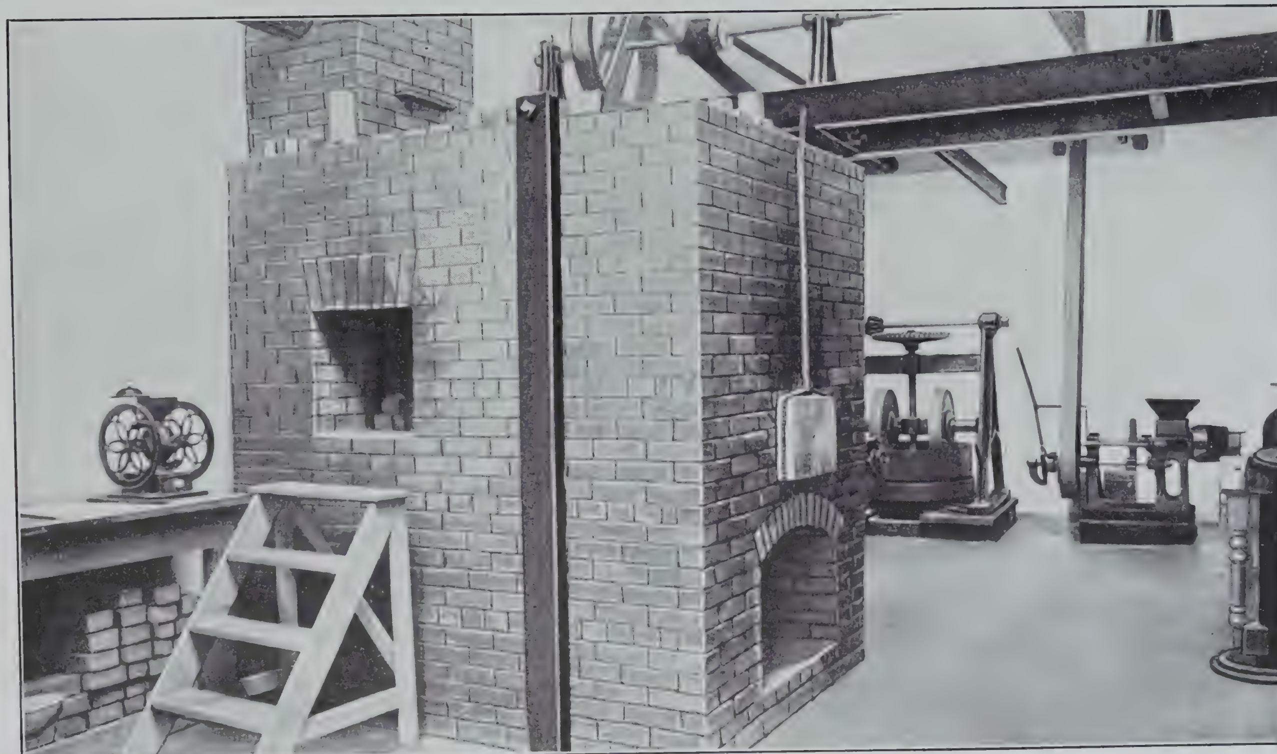


Asphalt mixer used in laying experimental bituminous sand pavement in Edmonton.

PLATE V.

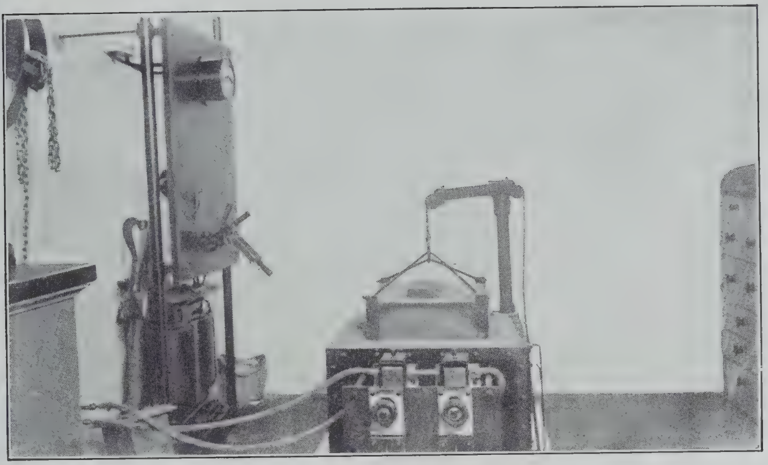


Ceramic laboratory: moulding room.



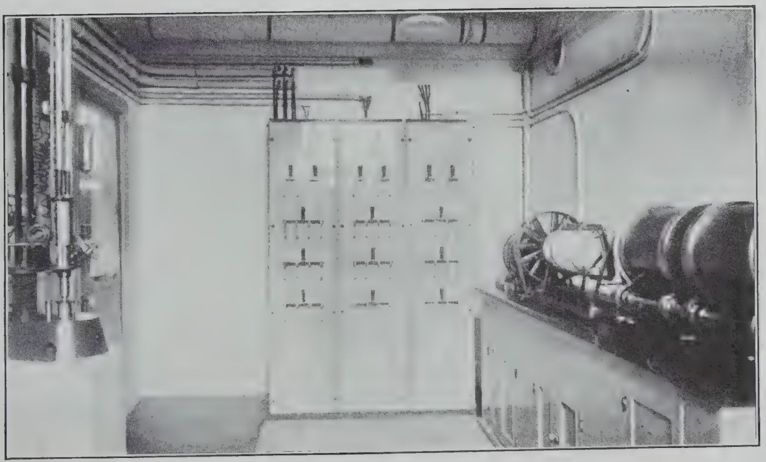
Ceramic laboratory: kiln room.

Plate VII.



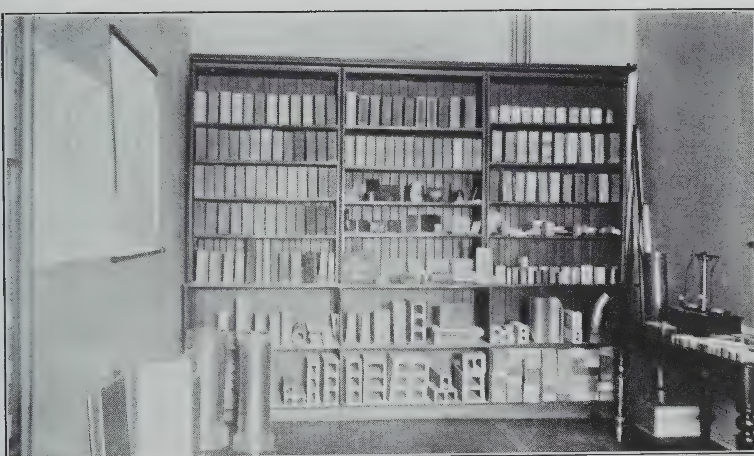
Ceramic laboratory: Hoskins electric furnace for testing refractory clays.

Plate VIII.



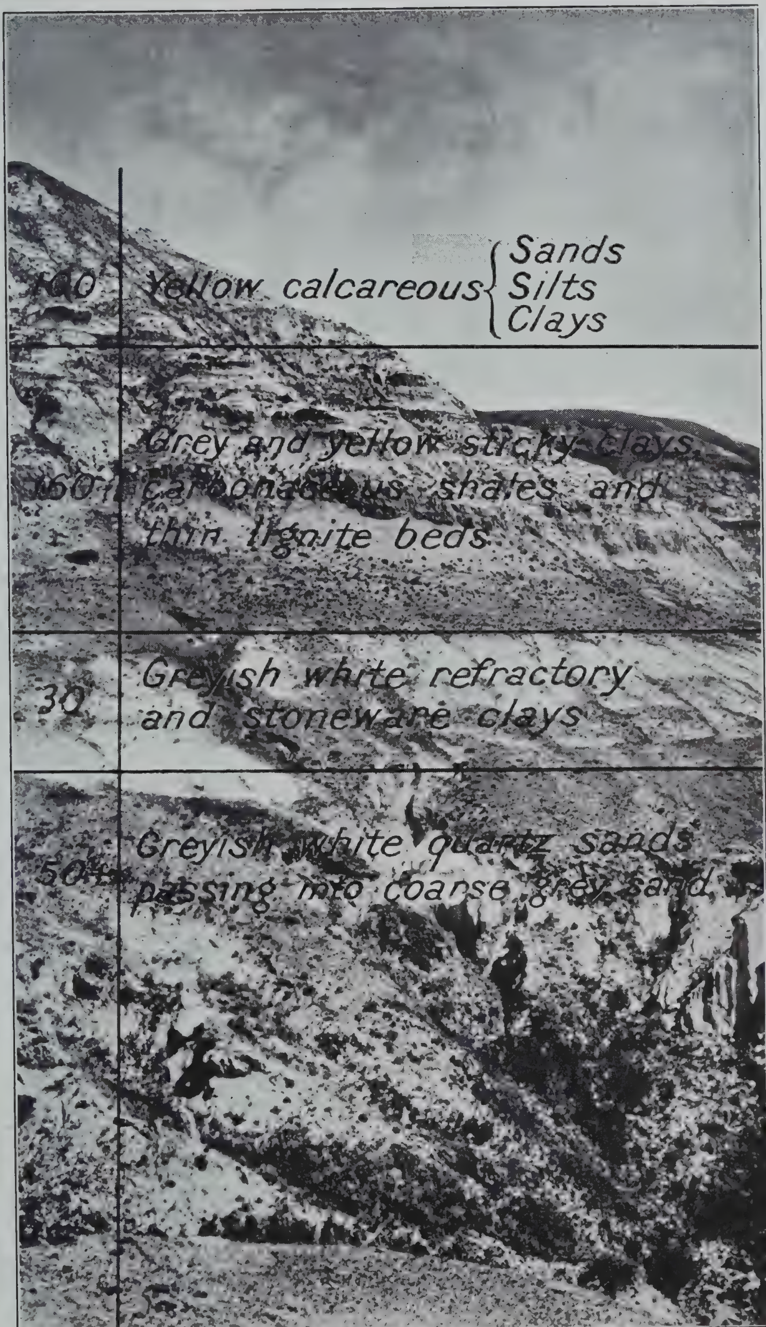
Ceramic laboratory: pebble grinding mills, switchboard, and impact machine.

PLATE IX.



Ceramic laboratory: finished clay products exhibit.

White clay outcrop in valley of Frenchman river, Ravenscraig, Saskatchewan.



Section of Fort Union beds near Ravenscraig, Saskatchewan.

Stoneware pieces made from Eastend clays.

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CATALOGUE

OF

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CANADA

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HON. P. E. BLONDIN, MINISTER; R. G. McCONNELL, DEPUTY MINISTER

MINES BRANCH

EUGENE HAANEL, PH.D., DIRECTOR

REPORTS AND MAPS

PUBLISHED BY THE

MINES BRANCH

REPORTS

†1. Mining conditions in the Klondike, Yukon. Report on—by Eugene Haanel, Ph.D., 1902.

†2. Great landslide at Frank, Alta. Report on—by R. G. McConnell, B.A., and R. W. Brock, M.A., 1903.

†3. Investigation of the different electro-thermic processes for the smelting of iron ores and the making of steel, in operation in Europe. Report of Special Commission—by Eugene Haanel, Ph.D., 1904.

5. On the location and examination of magnetic ore deposits by magnetometric measurements—by Eugene Haanel, Ph.D., 1904.

†7. Limestones, and the lime industry of Manitoba. Preliminary report on—by J. W. Wells, M.A., 1905.

†8. Clays and shales of Manitoba: their industrial value. Preliminary report on—by J. W. Wells, M.A., 1905.

†9. Hydraulic cements (raw materials) in Manitoba; manufacture and uses of. Preliminary report on—by J. W. Wells, M.A., 1905.

†10. Mica: its occurrence, exploitation, and uses—by Fritz Cirkel, M.E., 1905. (See No. 118.)

†11 Asbestos: its occurrence, exploitation, and uses—by Fritz Cirkel, M.E., 1905. (See No. 69.)

†12. Zinc resources of British Columbia and the conditions affecting their exploitation. Report of the Commission appointed to investigate—by W. R. Ingalls, M.E., 1905.

†16. Experiments made at Sault Ste. Marie, under Government auspices in the smelting of Canadian iron ores by the electro-thermic process. Final report on—by Eugene Haanel, Ph.D., 1907.

† Publications marked thus † are out of print.

†17. Mines of the silver-cobalt ores of the Cobalt district: their present and prospective output. Report on—by Eugene Haanel, Ph.D., 1907.

†18. Graphite: its properties, occurrences, refining, and uses—by Fritz Cirkel, M.E., 1907.

†19. Peat and lignite: their manufacture and uses in Europe—by Erik Nystrom, M.E., 1908.

†20. Iron ore deposits of Nova Scotia. Report on (Part I)—by J. E. Woodman, D.Sc.

†21. Summary report of Mines Branch, 1907–8.

†22. Iron ore deposits of Thunder Bay and Rainy River districts. Report on—by F. Hille, M.E.

†23. Iron ore deposits along the Ottawa (Quebec side) and Gatineau rivers. Report on—by Fritz Cirkel, M.E.

24. General report on the mining and metallurgical industries of Canada, 1907–8.

†25. The tungsten ores of Canada. Report on—by T. L. Walker, Ph.D.

26. The mineral production of Canada, 1906. Annual report on—by John McLeish, B.A.

†27. The mineral production of Canada, 1907. Preliminary report on—by John McLeish, B.A.

†27a. The mineral production of Canada, 1908. Preliminary report on—by John McLeish, B.A.

†28. Summary report of Mines Branch, 1908.

29. Chrome iron ore deposits of the Eastern Townships. Monograph on—by Fritz Cirkel. (Supplementary section: Experiments with chromite at McGill University—by J. B. Porter, E.M., D.Sc.)

30. Investigation of the peat bogs and peat fuel industry of Canada, 1908, Bulletin No. 1—by Erik Nystrom, M.E., and A. Anrep. Peat Expert.

32. Investigation of electric shaft furnace, Sweden. Report on—by Eugene Haanel, Ph.D.

47. Iron ore deposits of Vancouver and Texada islands. Report on—by Einar Lindeman, M.E.

†55. The bituminous, or oil-shales of New Brunswick and Nova Scotia; also on the oil-shale industry of Scotland. Report on—by R. W. Ells, LL.D.

† Publications marked thus † are out of print.

58. The mineral production of Canada, 1907 and 1908. Annual report on—by John McLeish, B.A.

Note.—*The following parts were separately printed and issued in advance of the Annual Report for 1907–08.*

†31. Production of cement in Canada, 1908.

†42. Production of iron and steel in Canada during the calendar years 1907 and 1908.

43. Production of chromite in Canada during the calendar years 1907 and 1908.

44. Production of asbestos in Canada during the calendar years 1907 and 1908.

†45. Production of coal, coke, and peat in Canada during the calendar years 1907 and 1908.

46. Production of natural gas and petroleum in Canada during the calendar years 1907 and 1908.

59. Chemical analyses of special economic importance made in the laboratories at the Department of Mines, 1906–07–08. Report on—by F. G. Wait, M.A., F.C.S. (With Appendix on the commercial methods and apparatus for the analyses of oil-shales—by H. A. Leverin, Ch.E.)

Schedule of charges for chemical analyses and assays.

†62. Mineral production of Canada, 1909. Preliminary report on—by John McLeish, B.A.

63. Summary report of Mines Branch, 1909.

67. Iron deposits of the Bristol mine, Pontiac county, Quebec. Bulletin No. 2—by Einar Lindeman, M.E., and Geo. C. Mackenzie, B.Sc.

†68. Recent advances in the construction of electric furnaces for the production of pig iron, steel, and zinc. Bulletin No. 3—by Eugene Haanel, Ph.D.

69. Chrysotile-asbestos: its occurrence, exploitation, milling, and uses. Report on—by Fritz Cirkel, M.E. (Second edition, enlarged.)

†71. Investigation of the peat bogs and peat industry of Canada, 1909–10; to which is appended Mr. Alf. Larson's paper on Dr. M. Ekenberg's wet-carbonizing process: from Teknisk Tidskrift, No. 12, December 26, 1908—translation by Mr. A. Anrep, Jr.; also a translation of Lieut. Ekelund's pamphlet entitled "A solution of the peat problem," 1909, describing the Ekelund process for the manufacture of peat powder, by Harold A. Leverin, Ch.E. Bulletin No. 4—by A. Anrep. (Second edition, enlarged.)

† Publications marked thus † are out of print.

82. Magnetic concentration experiments. Bulletin No. 5—by Geo. C. Mackenzie, B.Sc.

83. An investigation of the coals of Canada with reference to their economic qualities: as conducted at McGill University under the authority of the Dominion Government. Report on—by J. B. Porter, E.M., D.Sc., R. J. Durley, Ma.E., and others.
   Vol. I—Coal washing and coking tests.
   Vol. II—Boiler and gas producer tests.
   †Vol. III—
      Appendix I
         Coal washing tests and diagrams.
   †Vol. IV—
      Appendix II
         Boiler tests and diagrams.
   †Vol. V—
      Appendix III
         Producer tests and diagrams.
   †Vol. VI—
      Appendix IV
         Coking tests.
      Appendix V
         Chemical tests.

†84. Gypsum deposits of the Maritime provinces of Canada—including the Magdalen islands. Report on—by W. F. Jennison, M.E. (See No. 245.)

88. The mineral production of Canada, 1909. Annual report on—by John McLeish, B.A.

   NOTE.—*The following parts were separately printed and issued in advance of the Annual Report for 1909.*

   †79. Production of iron and steel in Canada during the calendar year 1909.
   †80. Production of coal and coke in Canada during the calendar year 1909.
   85. Production of cement, lime, clay products, stone, and other structural materials during the calendar year 1909.

89. Proceedings of conference on explosives. (Fourth edition).

90. Reprint of presidential address delivered before the American Peat Society at Ottawa, July 25, 1910. By Eugene Haanel, Ph.D.

92. Investigation of the explosives industry in the Dominion of Canada, 1910. Report on—by Capt. Arthur Desborough. (Fourth edition).

†93. Molybdenum ores of Canada. Report on—by Professor T. L. Walker Ph.D.

100. The building and ornamental stones of Canada: Building and ornamental stones of Ontario. Report on—by Professor W. A. Parks, Ph.D.

† Publications marked thus † are out of print.

102. Mineral production of Canada, 1910. Preliminary report on—by John McLeish, B.A.

†103. Summary report of Mines Branch, 1910.

104. Catalogue of publications of Mines Branch, from 1902 to 1911; containing tables of contents and lists of maps, etc.

105. Austin Brook iron-bearing district. Report on—by E. Lindeman, M.E.

110. Western portion of Torbrook iron ore deposits, Annapolis county, N.S. Bulletin No. 7—by Howells Frechette, M.Sc.

111. Diamond drilling at Point Mamainse, Ont. Bulletin No. 6—by A. C. Lane, Ph.D., with introductory by A. W. G. Wilson, Ph.D.

118. Mica: its occurrence, exploitation, and uses. Report on—by Hugh S. de Schmid, M.E.

142. Summary report of Mines Branch, 1911.

143. The mineral production of Canada, 1910. Annual report on—by John McLeish, B.A.

Note.—*The following parts were separately printed and issued in advance of the Annual Report for 1910.*

†114. Production of cement, lime, clay products, stone, and other materials in Canada, 1910.
†115. Production of iron and steel in Canada during the calendar year 1910.
†116. Production of coal and coke in Canada during the calendar year 1910.
†117. General summary of the mineral production of Canada during the calendar year 1910.

145. Magnetic iron sands of Natashkwan, Saguenay county, Que. Report on—by Geo. C. Mackenzie, B.Sc.

†150. The mineral production of Canada, 1911. Preliminary report on—by John McLeish, B.A.

151. Investigation of the peat bogs and peat industry of Canada, 1910–11. Bulletin No. 8—by A. Anrep.

154. The utilization of peat for fuel for the production of power, being a record of experiments conducted at the Fuel Testing Station, Ottawa, 1910–11. Report on—by B. F. Haanel, B.Sc.

167. Pyrites in Canada: its occurrence, exploitation, dressing and uses. Report on—by A. W. G. Wilson, Ph.D.

170. The nickel industry: with special reference to the Sudbury region, Ont. Report on—by Professor A. P. Coleman, Ph.D.

† Publications marked thus † are out of print.

184. Magnetite occurrences along the Central Ontario railway. Report on—by E. Lindeman, M.E.

201. The mineral production of Canada during the calendar year 1911. Annual report on—by John McLeish, B.A.

Note.—*The following parts were separately printed and issued in advance of the Annual Report for 1911.*

181. Production of cement, lime, clay products, stone, and other structural materials in Canada during the calendar year 1911. Bulletin on—by John McLeish, B.A.

†182. Production of iron and steel in Canada during the calendar year 1911. Bulletin on—by John McLeish, B.A.

183. General summary of the mineral production in Canada during the calendar year 1911. Bulletin on—by John McLeish, B.A.

†199. Production of copper, gold, lead, nickel, silver, zinc, and other metals of Canada, during the calendar year 1911. Bulletin on—by C. T. Cartwright, B.Sc.

†200. The production of coal and coke in Canada during the calendar year 1911. Bulletin on—by John McLeish, B.A.

203. Building stones of Canada—Vol. II: Building and ornamental stones of the Maritime Provinces. Report on—by W. A. Parks, Ph.D.

209. The copper smelting industry of Canada. Report on—by A. W. G. Wilson, Ph.D.

216. Mineral production of Canada, 1912. Preliminary report on—by John McLeish, B.A.

222. Lode mining in Yukon: an investigation of the quartz deposits of the Klondike division. Report on—by T. A. MacLean, B.Sc.

224. Summary report of the Mines Branch, 1912.

227. Sections of the Sydney coal fields—by J. G. S. Hudson, M.E.

†229. Summary report of the petroleum and natural gas resources of Canada, 1912—by F. G. Clapp, A.M. (See No. 224).

230. Economic minerals and mining industries of Canada.

245. Gypsum in Canada: its occurrence, exploitation, and technology. Report on—by L. H. Cole, B.Sc.

254. Calabogie iron-bearing district. Report on—by E. Lindeman, M.E.

259. Preparation of metallic cobalt by reduction of the oxide. Report on—by H. T. Kalmus, B.Sc., Ph.D.

† Publications marked thus † are out of print.

262. The mineral production of Canada during the calendar year 1912. Annual report on—by John McLeish, B.A.

Note.—*The following parts were separately printed and issued in advance of the Annual Report for 1912.*

238. General summary of the mineral production of Canada during the calendar year 1912. Bulletin on—by John McLeish, B.A.

†247. Production of iron and steel in Canada during the calendar year 1912. Bulletin on—by John McLeish, B.A.

†256. Production of copper, gold, lead, nickel, silver, zinc, and other metals of Canada, during the calendar year 1912—by C. T. Cartwright, B.Sc.

257. Production of cement, lime, clay products, stone, and other structural materials during the calendar year 1912. Report on—by John McLeish, B.A.

†258. Production of coal and coke in Canada, during the calendar year 1912. Bulletin on—by John McLeish, B.A.

266. Investigation of the peat bogs and peat industry of Canada, 1911 and 1912. Bulletin No. 9—by A. Anrep.

279. Building and ornamental stones of Canada—Vol. III: Building and ornamental stones of Quebec. Report on—by W. A. Parks, Ph.D.

281. The bituminous sands of Northern Alberta. Report on—by S. C. Ells, M.E.

283. Mineral production of Canada, 1913. Preliminary report on—by John McLeish, B.A.

285. Summary report of the Mines Branch, 1913.

291. The petroleum and natural gas resources of Canada. Report on—by F. G. Clapp, A.M., and others:—
Vol. I—Technology and exploitation.
Vol. II—Occurrence of petroleum and natural gas in Canada.
Also separates of Vol. II, as follows:—
Part 1, Eastern Canada.
Part 2, Western Canada.

299. Peat, lignite, and coal: their value as fuels for the production of gas and power in the by-product recovery producer. Report on—by B. F. Haanel, B.Sc.

303. Moose Mountain iron-bearing district. Report on—by E. Lindeman, M.E.

305. The non-metallic minerals used in the Canadian manufacturing industries. Report on—by Howells Fréchette, M.Sc.

309. The physical properties of cobalt, Part II. Report on—by H. T. Kalmus, B.Sc., Ph.D.

† Publications marked thus † are out of print.

349. Production of iron and steel in Canada during the calendar year, 1914. Bulletin on—by J. McLeish, B.A.

350. Production of copper, gold, lead, nickel, silver, zinc, and other metals, during the calendar year, 1914. Bulletin on—by J. McLeish, B.A.

383. The production of cement, lime, clay products, stone and other structural materials, during the calendar year 1914. Bulletin on—by John McLeish, B.A.

385. Investigation of a reported discovery of phosphate at Banff, Alberta. Bulletin No. 12—by H. S. de Schmid, M.E., 1915.

388. The building and ornamental stones of Canada—Vol. IV: building and ornamental stones of the western provinces. Report on—by W. A. Parks, Ph.D.

401. Feldspar in Canada. Report on—by H. S. de Schmid, M.E.

406. Description of the laboratories of the Mines Branch of the Department of Mines, 1916. Bulletin No. 13.

408. Mineral production of Canada, 1915. Preliminary report on—by John McLeish, B.A.

411. Cobalt alloys with non-corrosive properties. Report on—by H. T. Kalmus, B.Sc., Ph.D.

413. Magnetic properties of cobalt and of Fe_2Co. Report on—by H. T. Kalmus, B.Sc., Ph.D.

419. Production of iron and steel in Canada during the calendar year, 1915. Bulletin on—by J. McLeish, B.A.

421. Summary report of the Mines Branch for 1915.

424. General summary of the mineral production of Canada during the calendar year, 1915. Bulletin on—by John McLeish, B.A.

The Division of Mineral Resources and Statistics has prepared the following lists of mine, smelter, and quarry operators: Metal mines and smelters, General list of mines (except coal and metal mines), Coal mines, Stone quarry operators, Manufacturers of clay products and of cement, Manufacturers of lime, and Operators of sand and gravel deposits. Copies of the lists may be obtained on application.

IN THE PRESS

420. Production of coal and coke in Canada during the calendar year, 1915. Bulletin on—by J. McLeish, B.A.

423. The production of cement, lime, clay products, stone and other structural materials in Canada, during the calendar year, 1915. Bulletin on—by John McLeish, B.A.

425. The production of copper, gold, lead, nickel, silver, zinc, and other metals in Canada, during the calendar year, 1915. Bulletin on—by John McLeish, B.A.

426. The mineral production of Canada during the calendar year, 1915. Annual report on—by John McLeish, B.A.

428. The production of spelter in Canada, 1915. Report on—by Dr. A. W. G. Wilson.

430. The coal-fields and coal industry of eastern Canada. Report on—by Francis W. Gray.

FRENCH TRANSLATIONS

971. (26a) Rapport annuel sur les industries minérales du Canada, pour l'année 1905.

†4. Rapport de la Commission nominée pour étudier les divers procédés électro-thermiques pour la réduction des minerais de fer et la fabrication de l'acier employés en Europe—by Eugene Haanel, Ph.D. (French Edition), 1905.

26a. The mineral production of Canada, 1906. Annual report on—by John McLeish, B.A.

†28a. Summary report of Mines Branch, 1908.

56. Bituminous or oil-shales of New Brunswick and Nova Scotia; also on the oil-shale industry of Scotland. Report on—by R. W. Ells, LL.D.

81. Chrysotile-asbestos, its occurrence, exploitation, milling, and uess Report on—by Fritz Cirkel, M.E.

100a. The building and ornamental stones of Canada: Building and ornamental stones of Ontario. Report on—by W. A. Parks, Ph.D.

149. Magnetic iron sands of Natashkwan, Saguenay county, Que. Report on—by Geo. C. Mackenzie, B.Sc.

155. The utilization of peat fuel for the production of power, being a record of experiments conducted at the Fuel Testing Station, Ottawa, 1910–11. Report on—by B. F. Haanel, B.Sc.

†156. The tungsten ores of Canada. Report on—by T. L. Walker, Ph.D.

169. Pyrites in Canada: its occurrences, exploitation, dressing, and uses.. Report on—by A. W. G. Wilson, Ph.D.

179. The nickel industry: with special reference to the Sudbury region, Ont. Report on—by Professor A. P. Coleman, Ph.D.

180. Investigation of the peat bogs, and peat industry of Canada, 1910–11. Bulletin No. 8—by A. Anrep.

195. Magnetite occurrences along the Central Ontario railway. Report on —by E. Lindeman, M.E.

†196. Investigation of the peat bogs and peat industry of Canada, 1909–10, to which is appended Mr. Alf. Larson's paper on Dr. M. Ekenburg's wet-carbonizing process: from Teknisk Tidskrift, No. 12, December 26, 1908—translation by Mr. A. Anrep; also a translation of Lieut. Ekelund's pamphlet entitled "A solution of the peat problem," 1909, describing the Ekelund process for the manufacture of peat powder, by Harold A. Leverin, Ch.E. Bulletin No. 4—by A. Anrep. (Second Edition, enlarged.)

197. Molybdenum ores of Canada. Report on—by T. L. Walker, Ph.D.

† Publications marked thus † are out of print.

†198. Peat and lignite: their manufacture and uses in Europe. Report on—by Erik Nystrom, M.E., 1908.

202. Graphite: its properties, occurrences, refining, and uses. Report on—by Fritz Cirkel, M.E., 1907.

204. Building stones of Canada—Vol. II: Building and ornamental stones of the Maritime Provinces. Report on—by W. A. Parks, Ph.D.

219. Austin Brook iron-bearing district. Report on—by E. Lindeman, M.E.

223. Lode Mining in the Yukon: an investigation of quartz deposits in the Klondike division. Report on—by T. A. MacLean, B.Sc.

224a. Mines Branch Summary report for 1912.

†226. Chrome iron ore deposits of the Eastern Townships. Monograph on—by Fritz Cirkel, M.E. (Supplementary section: Experiments with chromite at McGill University—by J. B. Porter, E.M., D.Sc.).

231. Economic minerals and mining industries of Canada.

233. Gypsum deposits of the Maritime Provinces of Canada—including the Magdalen islands. Report on—by W. F. Jennison, M.E.

246. Gypsum in Canada: its occurrence, exploitation, and technology. Report on—by L. H. Cole, B.Sc.

260. The preparation of metallic cobalt by reduction of the oxide. Report on—by H. T. Kalmus, B.Sc., Ph.D.

263. Recent advances in the construction of electric furnaces for the production of pig iron, steel, and zinc. Bulletin No. 3—by Eugene Haanel, Ph.D.

†264. Mica: its occurrence, exploitation, and uses. Report on—by Hugh S. de Schmid, M.E.

265. Annual mineral production of Canada, 1911. Report on—by John McLeish, B.A.

280. The building and ornamental stones of Canada, Vol. III; Province of Quebec. Report on—by Professor W. A. Parks, Ph.D.

282. The bituminous sands of Northern Alberta. Report on—by S. C. Ells, M.E.

286. Summary Report of Mines Branch, 1913.

287. Production of iron and steel in Canada during the calendar year 1912. Bulletin on—by John McLeish, B.A.

288. Production of coal and coke in Canada, during the calendar year 1912. Bulletin on—by John McLeish, B.A.

† Publications marked thus † are out of print.

289. Production of cement, lime, clay products, stone, and other structural materials during the calendar year 1912. Bulletin on—by John McLeish, B.A.

290. Production of copper, gold, lead, nickel, silver, zinc, and other metals of Canada during the calendar year 1912. Bulletin on—by C. T. Cartwright, B.Sc.

307. Cataologue of French publications of the Mines Branch and of the Geological Survey, up to July, 1914.

308. An investigation of the coals of Canada with reference to their economic qualities: as conducted at McGill University under the authority of the Dominion Government. Report on—by J. B. Porter, E.M., D.Sc., R. J. Durley, Ma.E., and others.
Vol. I—Coal washing and coking tests.
Vol. II—Boiler and gas producer tests.
Vol. III—
Appendix I
Coal washing tests and diagrams.
Vol. IV—
Appendix II
Boiler tests and diagrams.

314. Iron ore deposits, Bristol mine, Pontiac county, Quebec, Report on—by E. Lindeman, M.E.

321. Annual mineral production of Canada, during the calendar year 1913. Report on—by J. McLeish, B.A.

415. Annual mineral production of Canada during the calendar year, 1914. Report on—by J. McLeish, B.A.

IN THE PRESS

292. The petroleum and natural gas resources of Canada. Report on—by F. G. Clapp, A.M., and others.
Vol. I.—Technology and exploitation.

306. The non-metallic minerals used in the Canadian manufacturing industries Report on—by Howells Fréchette, M.Sc.

310. The physical properties of the metal cobalt, Part II. Report on—by H. T. Kalmus, B.Sc., Ph.D.

324. Products and by-products of coal. Report on—by Edgar Stansfield M.Sc., and F. E. Carter, B.Sc., Dr. Ing.

326. The salt industry of Canada. Report on—by L. H. Cole, B.Sc.

MAPS

†6. Magnetometric survey, vertical intensity: Calabogie mine, Bagot township, Renfrew county, Ontario—by E. Nystrom, 1904. Scale 60 feet to 1 inch. Summary report 1905. (See Map No. 249.)

†13. Magnetometric survey of the Belmont iron mines, Belmont township, Peterborough county, Ontario—by B. F. Haanel, 1905. Scale 60 feet to 1 inch. Summary report, 1906. (See Map No. 186).

†14. Magnetometric survey of the Wilbur mine, Lavant township, Lanark county, Ontario—by B. F. Haanel, 1905. Scale 60 feet to 1 inch. Summary report, 1906.

†33. Magnetometric survey, vertical intensity: lot 1, concession VI, Mayo township, Hastings county, Ontario—by Howells Fréchette, 1909. Scale 60 feet to 1 inch. (See Maps Nos. 191 and 191A.)

†34. Magnetometric survey, vertical intensity: lots 2 and 3, concession VI, Mayo township, Hastings county, Ontario—by Howells Fréchette, 1909. Scale 60 feet to 1 inch. (See Maps Nos. 191 and 191A.)

†35. Magnetometric survey, vertical intensity: lots 10, 11, and 12 concession IX, and lots 11 and 12, concession VIII, Mayo township, Hastings county. Ontario—by Howells Fréchette, 1909. Scale 60 feet to 1 inch. (See Maps Nos. 191 and 191A.)

*36. Survey of Mer Bleue peat bog, Gloucester township, Carleton county, and Cumberland township, Russell county, Ontario—by Erik Nystrom, and A. Anrep. (Accompanying report No. 30.)

*37. Survey of Alfred peat bog. Alfred and Caledonia townships, Prescott county, Ontario—by Erik Nystrom and A. Anrep. (Accompanying report No. 30.)

*38. Survey of Welland peat bog, Wainfleet and Humberstone townships, Welland county, Ontario—by Erik Nystrom and A. Anrep. (Accompanying report No. 30.)

*39. Survey of Newington peat bog, Osnabruck, Roxborough, and Cornwall townships, Stormont county, Ontario—by Erik Nystrom and A. Anrep. (Accompanying report No. 30.)

*40. Survey of Perth peat bog, Drummond township, Lanark county, Ontario—by Erik Nystrom and A. Anrep. (Accompanying report No. 30.)

†41. Survey of Victoria Road peat bog, Bexley and Carden townships, Victoria county, Ontario—Erik Nystrom and A. Anrep. (Accompanying report No. 30).

*48. Magnetometric survey of Iron Crown claim at Nimpkish (Klaanch) river, Vancouver island, B.C.—by E. Lindeman. Scale 60 feet to 1 inch. (Accompanying report No. 47).

Note.—1. Maps marked thus * are to be found only in reports.
2. Maps marked thus † have been printed independently of reports, hence can be procured separately by applicants.

*49. Magnetometric survey of Western Steel Iron claim, at Sechart, Vancouver island, B.C.—By E. Lindeman. Scale 60 feet to 1 inch. (Accompanying report No. 47.)

*53. Iron ore occurrences, Ottawa and Pontiac counties, Quebec, 1908—by J. White and Fritz Cirkel. (Accompanying report No. 23.)

*54. Iron ore occurrences, Argenteuil county, Quebec, 1908—by Fritz Cirkel. (Accompanying report No. 23.) Out of print.

†57. The productive chrome iron ore district of Quebec—by Fritz Cirkel. (Accompanying report No. 29.)

†60. Magnetometric survey of the Bristol mine, Pontiac county, Quebec—by E. Lindeman. Scale 200 feet to 1 inch. (Accompanying report No. 67.)

†61. Topographical map of Bristol mine, Pontiac county, Quebec—by E. Lindeman. Scale 200 feet to 1 inch. (Accompanying report No. 67.)

†64. Index map of Nova Scotia: Gypsum—by W. F. Jennison.

†65. Index map of New Brunswick: Gypsum—by W. F. Jennison.

†66. Map of Magdalen islands: Gypsum—by W. F. Jennison....

(Accompanying report No. 84).

†70. Magnetometric survey of Northeast Arm iron range, Lake Timagami, Nipissing district, Ontario—by E. Lindeman. Scale 200 feet to 1 inch. (Accompanying report No. 63.)

†72. Brunner peat bog, Ontario—by A. Anrep.

†73. Komoka peat bog, Ontario— " "

†74. Brockville peat bog, Ontario— " "

†75. Rondeau peat bog, Ontario— " "

†76. Alfred peat bog, Ontario— " "

†77. Alfred peat bog, Ontario, main ditch profile—by A. Anrep.

(Accompanying report No. 71.)

(Out of print.)

†78. Map of asbestos region, Province of Quebec, 1910—by Fritz Cirkel. Scale 1 mile to 1 inch. (Accompanying report No. 69.)

†94. Map showing Cobalt, Gowganda, Shiningtree, and Porcupine districts —by L. H. Cole. (Accompanying Summary report, 1910.)

†95. General map of Canada, showing coal fields. (Accompanying report No. 83—by Dr. J. B. Porter.)

†96. General map of coal fields of Nova Scotia and New Brunswick. (Accompanying report No. 83—by Dr. J. B. Porter.)

†97. General map showing coal fields in Alberta, Saskatchewan, and Manitoba. (Accompanying report No. 83—by Dr. J. B. Porter.)

Note.—1. Maps marked thus * are to be found only in reports.
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†98. General map of coal fields in British Columbia. (Accompanying report No. 83—by Dr. J. B. Porter.)

†99. General map of coal field in Yukon Territory. (Accompanying report No. 83—by Dr. J. B. Porter.)

†106. Geological map of Austin Brook iron-bearing district, Bathurst township, Gloucester county, N.B.—by E. Lindeman. Scale 400 feet to 1 inch. (Accompanying report No. 105.)

†107. Magnetometric survey, vertical intensity: Austin Brook iron-bearing district—by E. Lindeman. Scale 400 feet to 1 inch. (Accompanying report No. 105.)

†108. Index map showing iron-bearing area at Austin Brook—by E. Lindeman. (Accompanying report No. 105.)

*112. Sketch plan showing geology of Point Mamainse, Ont.—by Professor A. C. Lane. Scale 4,000 feet to 1 inch. (Accompanying report No. 111.)

†113. Holland peat bog Ontario—by A. Anrep. (Accompanying report No. 151.)

*119–137. Mica: township maps, Ontario and Quebec—by Hugh S. de Schmid. (Accompanying report No. 118.)

†138. Mica: showing location of principal mines and occurrences in the Quebec mica area—by Hugh S. de Schmid. Scale 3·95 miles to 1 inch. (Accompanying report No. 118.)

†139. Mica: showing location of principal mines and occurrences in the Ontario mica area—by Hugh S. de Schmid. Scale 3·95 miles to 1 inch. (Accompanying report No. 118.)

†140. Mica: showing distribution of the principal mica occurrences in the Dominion of Canada—by Hugh S. de Schmid. Scale 3·95 miles to 1 inch. (Accompanying report No. 118.)

†141. Torbrook iron-bearing district Annapolis county, N.S.—by Howells Fréchette. Scale 400 feet to 1 inch. (Accompanying report No. 110.)

146. Distribution of iron ore sands of the iron ore deposits on the north shore of the River and Gulf of St. Lawrence, Canada—by Geo. C. Mackenzie. Scale 100 miles to 1 inch. (Accompanying report No. 145.)

†147. Magnetic iron sand deposits in relation to Natashkwan harbour and Great Natashkwan river, Que. (Index Map)—by Geo. C. Mackenzie. Scale 40 chains to 1 inch. (Accompanying report No. 145.)

†148. Natashkwan magnetic iron sand deposits, Saguenay county, Que.—by Geo. C. Mackenzie. Scale 1,000 feet to 1 inch. (Accompanying report No. 145.)

Note.—1. Maps marked thus * are to be found only in reports.
2. Maps marked thus † have been printed independently of reports, hence can be procured separately by applicants.

†152.	Map showing the location of peat bogs investigated in Ontario—by A. Anrep. (See Map No. 354.)	(Accompanying report No. 151.)
†153.	Map showing the location of peat bogs, as investigated in Manitoba—by A. Anrep.	
†157.	Lac du Bonnet peat bog, Manitoba—by A. Anrep.	
†158.	Transmission peat bog, Manitoba— " "	
†159.	Corduroy peat bog, Manitoba— " "	
†160.	Boggy Creek peat bog, Manitoba— " "	
†161.	Rice Lake peat bog, Manitoba— " "	
†162.	Mud Lake peat bog, Manitoba— " "	
†163.	Litter peat bog, Manitoba— " "	
†164.	Julius peat litter bog, Manitoba— " "	
†165.	Fort Frances peat bog, Ontario— " "	

*166. Magnetometric map of No. 3 mine, lot 7, concessions V and VI, McKim township, Sudbury district, Ont.—by E. Lindeman. (Accompanying Summary report, 1911.)

†168. Map showing pyrites mines and prospects in Eastern Canada, and their relation to the United States market—by A. W. G. Wilson. Scale 125 miles to 1 inch. (Accompanying report No. 167.)

†171. Geological map of Sudbury nickel region, Ont.—by Prof. A. P. Coleman. Scale 1 mile to 1 inch. (Accompanying report No. 170.)

†172.	Geological map of Victoria mine—by Prof. A. P. Coleman.	(Accompanying report No. 170.)
†173.	" Crean Hill mine—by Prof. A. P. Coleman	
†174.	" Creighton mine—by Prof. A. P. Coleman.	

†175. " showing contact of norite and Laurentian in vicinity of Creighton mine—by Prof. A. P. Coleman. (Accompanying report No. 170.)

†176. " Copper Cliff offset—by Prof. A. P. Coleman. (Accompanying report No. 170.)

†177. " No. 3 mine—by Prof. A. P. Coleman. (Accompanying report No. 170.)

†178. " showing vicinity of Stobie and No. 3 mines—by Prof. A. P. Coleman. (Accompanying report No. 170.)

Note.—1. Maps marked thus * are to be found only in reports.
2. Maps marked thus † have been printed independently of reports, hence can be procured separately by applicants.

†185. Magnetometric survey, vertical intensity: Blairton iron mine, Belmont township, Peterborough county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 184.)

†185a. Geological map, Blairton iron mine, Belmont township, Peterborough county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 184.)

†186. Magnetometric survey, Belmont iron mine, Belmont township, Peterborough county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 184.)

†186a. Geological map, Belmont iron mine, Belmont township, Peterborough county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 184.)

†187. Magnetometric survey, vertical intensity: St. Charles mine, Tudor township, Hastings county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 184.)

†187a. Geological map, St. Charles mine, Tudor township, Hastings county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 184.)

†188. Magnetometric survey, vertical intensity: Baker mine, Tudor township, Hastings county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 184.)

†188a. Geological map, Baker mine, Tudor township, Hastings county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 184.)

†189. Magnetometric survey, vertical intensity: Ridge iron ore deposits, Wollaston township, Hastings county, Ontario—by E. Lindeman. 1911. Scale 200 feet to 1 inch. (Accompanying report No. 184.)

†190. Magnetometric survey, vertical intensity: Coehill and Jenkins mines, Wollaston township, Hastings county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 184.)

†190a. Geological map, Coehill and Jenkins mines, Wollaston township, Hastings county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 184.)

†191. Magnetometric survey, vertical intensity: Bessemer iron ore deposits, Mayo township, Hastings county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 184.)

†191a. Geological map, Bessemer iron ore deposits, Mayo township, Hastings county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 184.)

†192. Magnetometric survey, vertical intensity: Rankin, Childs, and Stevens mines, Mayo township, Hastings county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 184.)

Note.—1. Maps marked thus * are to be found only in reports.
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†192a. Geological map, Rankin, Childs, and Stevens mines, Mayo township, Hastings county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 184.)

†193. Magnetometric survey, vertical intensity: Kennedy property, Carlow township, Hastings county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 184.)

†193a. Geological map, Kennedy property, Carlow township, Hastings county Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 184.)

†194. Magnetometric survey, vertical intensity: Bow Lake iron ore occurrences, Faraday township, Hastings county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 184.)

†204. Index map, magnetite occurrences along the Central Ontario railway—by E. Lindeman, 1911. (Accompanying report No. 184.)

†205. Magnetometric map, Moose Mountain iron-bearing district, Sudbury district, Ontario: Deposits Nos. 1, 2, 3, 4, 5, 6, and 7—by E. Lindeman, 1911. (Accompanying report No. 303.)

†205a. Geological map, Moose Mountain iron-bearing district, Sudbury district, Ontario, Deposits Nos. 1, 2, 3, 4, 5, 6, and 7—by E. Lindeman. (Accompanying report No. 303.)

†206. Magnetometric survey of Moose Mountain iron-bearing district, Sudbury district, Ontario: northern part of deposit No. 2—by E Lindeman, 1912. Scale 200 feet to 1 inch. (Accompanying report No. 303.)

†207. Magnetometric survey of Moose Mountain iron-bearing district, Sudbury district, Ontario: Deposits Nos. 8, 9, and 9A—by E. Lindeman, 1912. Scale 200 feet to 1 inch. (Accompanying report No. 303.)

†208. Magnetometric survey of Moose Mountain iron-bearing district, Sudbury district, Ontario: Deposit No. 10—by E. Lindeman, 1912. Scale 200 feet to 1 inch. (Accompanying report No. 303.)

†208a. Magnetometric survey, Moose Mountain iron-bearing district, Sudbury district, Ontario: eastern portion of Deposit No. 11—by E. Lindeman, 1912. Scale 200 feet to 1 inch. (Accompanying report No. 303.)

†208b. Magnetometric survey, Moose Mountain iron-bearing district, Sudbury district, Ontario: western portion of deposit No. 11—by E. Lindeman, 1912. Scale 200 feet to 1 inch. (Accompanying report No. 303.)

†208c. General geological map, Moose Mountain iron-bearing district, Sudbury district, Ontario—by E. Lindeman, 1912. Scale 800 feet to 1 inch. (Accompanying report No. 303.)

Note.—1. Maps marked thus * are to be found only in reports.
2. Maps marked thus † have been printed independently of reports hence can be procured separately by applicants.

*210. Location of copper smelters in Canada—by A. W. G. Wilson. Scale 197·3 miles to 1 inch. (Accompanying report No. 209.)

†215. Province of Alberta: showing properties from which samples of coal were taken for gas producer tests, Fuel Testing Division, Ottawa. (Accompanying Summary report, 1912.)

†220. Mining districts, Yukon. Scale 35 miles to 1 inch—by T. A. MacLean. (Accompanying report No. 222.)

†221. Dawson mining district, Yukon. Scale 2 miles to 1 inch—by T. A. MacLean. (Accompanying report No. 222.)

*228. Index map of the Sydney coal fields, Cape Breton, N.S. (Accompanying report No. 227.)

†232. Mineral map of Canada. Scale 100 miles to 1 inch. (Accompanying report No. 230.)

†239. Index map of Canada showing gypsum occurrences. (Accompanying report No. 245.)

†240. Map showing Lower Carboniferous formation in which gypsum occurs in the Maritime provinces. Scale 100 miles to 1 inch. (Accompanying report No. 345.)

†241. Map showing relation of gypsum deposits in Northern Ontario to railway lines. Scale 100 miles to 1 inch. (Accompanying report No. 245.)

†242. Map, Grand River gypsum deposits, Ontario. Scale 4 miles to 1 inch. (Accompanying report No. 245.)

†243. Plan of Manitoba Gypsum Co.'s properties. (Accompanying report No. 245.)

†244. Map showing relation of gypsum deposits in British Columbia to railway lines and market. Scale 35 miles to 1 inch. (Accompanying report No. 245.)

†249. Magnetometric survey, Caldwell and Campbell mines, Calabogie district, Renfrew county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 254.)

†250. Magnetometric survey, Black Bay or Williams mine, Calabogie district, Renfrew county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 254.)

†251. Magnetometric survey, Bluff Point iron mine, Calabogie district, Renfrew county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 254.)

†252. Magnetometric survey, Culhane mine, Calabogie district, Renfrew county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 254.)

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2. Maps marked thus † have been printed independently of reports, hence can be procured separately by applicants.

†253. Magnetometric survey, Martel or Wilson iron mine, Calabogie district, Renfrew county, Ontario—by E. Lindeman, 1911. Scale 200 feet to 1 inch. (Accompanying report No. 254.)

†261. Magnetometric survey, Northeast Arm iron range, lot 339 E.T.W. Lake Timagami, Nipissing district, Ontario—by E. Nystrom. 1903. Scale 200 feet to 1 inch.

†268. Map of peat bogs investigated in Quebec—by A. Anrep, 1912. (See Report No. 351.)

†269. Large Tea Field peat bog, Quebec " " "

†270. Small Tea Field peat bog, Quebec " " "

†271. Lanoraie peat bog, Quebec " " "

†272. St. Hyacinthe peat bog, Quebec " " "

†273. Rivière du Loup peat bog " " "

†274. Cacouna peat bog " " "

†275. Le Parc peat bog, Quebec " " "

†276. St. Denis peat bog, Quebec " " "

†277. Rivière Ouelle peat bog, Quebec " " "

†278. Moose Mountain peat bog, Quebec " " "

†284. Map of northern portion of Alberta, showing position of outcrops of bituminous sand. Scale 12½ miles to 1 inch. (Accompanying report No. 281.)

†293. Map of Dominion of Canada, showing the occurrences of oil, gas, and tar sands. Scale 197 miles to 1 inch. (Accompanying report No. 291.)

†294. Reconnaissance map of part of Albert and Westmorland counties, New Brunswick. Scale 1 mile to 1 inch. (Accompanying report No. 291.)

†295. Sketch plan of Gaspé oil fields, Quebec, showing location of wells. Scale 2 miles to 1 inch. (Accompanying report No. 291.)

†296. Map showing gas and oil fields and pipe-lines in southwestern Ontario. Scale 4 miles to 1 inch. (Accompanying report No. 291.)

†297. Geological map of Alberta, Saskatchewan, and Manitoba. Scale 35 miles to 1 inch. (Accompanying report No. 291.)

†298. Map, geology of the forty-ninth parallel, 0·9864 miles to 1 inch. (Accompanying report No. 291.)

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†302. Map showing location of main gas line, Bow Island, Calgary. Scale 12½ miles to 1 inch. (Accompanying report No. 291.)

†311. Magnetometric map, McPherson mine, Barachois, Cape Breton county, Nova Scotia—by A. H. A. Robinson, 1913. Scale 200 feet to 1 inch.

†312. Magnetometric map, iron ore deposits at Upper Glencoe, Inverness county, Nova Scotia—by E. Lindeman, 1913. Scale 200 feet to 1 inch.

†313. Magnetometric map, iron ore deposits at Grand Mira, Cape Breton county, Nova Scotia—by A. H. A. Robinson, 1913. Scale 200 feet to 1 inch.

†327. Map showing location of Saline Springs and Salt Areas in the Dominion of Canada. (Accompanying Report No. 325.)

†328. Map showing location of Saline Springs in the Maritime Provinces. Scale 100 miles to 1 inch. (Accompanying Report No. 325.)

†329. Map of Ontario-Michigan Salt Basin, showing probable limit of productive area. Scale 25 miles to 1 inch. (Accompanying Report No. 325.)

†330. Map showing location of Saline Springs in Northern Manitoba. Scale 12½ miles to 1 inch. (Accompanying Report No. 325.)

†340. Magnetometric map of Atikokan iron-bearing district, Atikokan Mine and Vicinity. Claims Nos. 10E, 11E, 12E, 24E, 25E, and 26E, Rainy River district, Ontario. By A. H. A. Robinson, 1914. Scale 400 feet to 1 inch.

†340a. Geological map of Atikokan iron-bearing district, Atikokan Mine and Vicinity. Claims Nos. 10E, 11E, 12E, 24E, 25E, and 26E, Rainy River district, Ontario. By A. H. A. Robinson, 1914. Scale 400 feet to 1 inch.

†341. Magnetometric map of Atikokan iron-bearing district, Sheet No. 1, Claims Nos. 400R, 401R, 402R, 112X, and 403R. Rainy River district, Ontario. By E. Lindeman, 1914. Scale 400 feet to 1 inch.

†341a. Geological map of Atikokan iron-bearing district. Sheet No. 1. Claims Nos. 400R, 401R, 402R, 112X, and 403R, Rainy River district, Ontario. By E. Lindeman, 1914. Scale 400 feet to 1 inch.

†342. Magnetometric map of Atikokan iron-bearing district. Sheet No. 2. Claims Nos. 403R, 404R, 138X, 139X, and 140X, Rainy River district, Ontario. By E. Lindeman, 1914. Scale 400 feet to 1 inch.

†342a. Geological map of Atikokan iron-bearing district. Sheet No. 2. Claims Nos. 403R, 404R, 138X, 139X, and 140X, Rainy River district, Ontario. By E. Lindeman, 1914. Scale 400 feet to 1 inch.

† Maps marked thus † have been printed independently of reports, hence can be procured separately by applicants.

†343. Magnetometric map of Atikokan iron-bearing district. Mile Post No. 140, Canadian Northern railway, Rainy River district, Ontario. By E. Lindeman, 1914. Scale 400 feet to 1 inch.

†343a. Geological map, Atikokan iron-bearing district. Mile Post No. 140, Canadian Northern railway, Rainy River district, Ontario. By E. Lindeman, 1914. Scale 400 feet to 1 inch.

†354.	Index Map, showing location of peat bogs investigated in Ontario—	by A. Anrep,	1913–14
†355.	Richmond peat bog, Carleton county, Ontario—	"	"
†356.	Luther peat bog, Wellington and Dufferin counties, Ontario—	"	"
†357.	Amaranth peat bog, Dufferin county, Ontario—	"	"
†358.	Cargill peat bog, Bruce county, Ontario—	"	"
†359.	Westover peat bog, Wentworth county, Ontario—	"	"
†360.	Marsh Hill peat bog, Ontario county, Ontario—	"	"
†361.	Sunderland peat bog, Ontario county, Ontario—	"	"
†362.	Manilla peat bog, Victoria county, Ontario—	"	"
†363.	Stoco peat bog, Hastings county, Ontario—	"	"
†364.	Clareview peat bog, Lennox and Addington counties, Ontario—	"	"
†365.	Index Map, showing location of peat bogs investigated in Quebec—	"	"
†366.	L'Assomption peat bog, L'Assomption county, Quebec—	"	"
†367.	St. Isidore peat bog, La Prairie county, Quebec—	"	"
†368.	Holton peat bog, Chateauguay county, Quebec—	"	"
†369.	Index Map, showing location of peat bogs investigated in Nova Scotia and Prince Edward Island—	"	"
†370.	Black Marsh peat bog, Prince county, Prince Edward Island—	"	"
†371.	Portage peat bog, Prince county, Prince Edward Island—	"	"
†372.	Miscouche peat bog, Prince county, Prince Edward Island—	"	"
†373.	Muddy Creek peat bog, Prince county, Prince Edward Island—	"	"
†374.	The Black Banks peat bog, Prince county, Prince Edward Island—	"	"

†Maps marked thus † have been printed independently of reports, hence can be procured separately by applicants.

†375. Mermaid peat bog, Queens county, Prince Edward Island..........................by A. Anrep, 1913–14.

†376. Caribou peat bog, Kings county, Prince Edward Island— " "

†377. Cherryfield peat bog, Lunenburg County, Nova Scotia— " "

†378. Tusket peat bog, Yarmouth county, Nova Scotia— " "

†379. Makoke peat bog, Yarmouth county, Nova Scotia— " "

†380. Heath peat bog, Yarmouth county, Nova Scotia— " "

†381. Port Clyde peat bog, Shelburne county, Nova Scotia— " "

†382. Latour peat bog, Shelburne county, Nova Scotia— " "

†383. Clyde peat bog, Shelburne county, Nova Scotia— " "

†387. Geological map Banff district, Alberta, showing location of phosphate beds—by Hugh S. de Schmid, 1915. (Accompanying report No. 385.)

†390. Christina river map showing outcrops of bituminous sand along Christina valley; contour intervals of 20 feet—by S. C. Ells, 1915. Scale 1,000 feet to 1 inch.

†391. Clearwater river map, showing outcrops of bituminous sand along Clearwater valley; contour intervals of 20 feet—by S. C. Ells, 1915. Scale 1,000 feet to 1 inch.

†392. Hangingstone-Horse rivers, showing outcrops of bituminous sand along Hangingstone and Horse River valleys: contour intervals of 20 feet—by S. C. Ells, 1915. Scale 1,000 feet to 1 inch.

†393. Steepbank river, showing outcrops of bituminous sand along Steepbank valley; contour intervals of 20 feet—by S. C. Ells, 1915. Scale 1,000 feet to 1 inch.

†394. McKay river, 3 sheets, showing outcrops of bituminous sand along McKay valley; contour intervals of 20 feet—by S. C. Ells, 1915. Scale 1,000 feet to 1 inch.

†395. Moose river, showing outcrops of bituminous sand along Moose valley; contour intervals of 20 feet—by S. C. Ells, 1915. Scale 1,000 feet to 1 inch.

398. Ontario phosphate area—by Hugh S. deSchmid.

399. Quebec phosphate area— ,, ,, ,, ,,

403. Ontario feldspar area— ,, ,, ,, ,,

404. Quebec feldspar area— ,, ,, ,, ,,

† Maps marked thus † have been printed independently of reports, hence can be procured separately by applicants.

405. Magnetometric map, Orton mine and vicinity, Hastings county, Ontario—by A. H. A. Robinson, 1915.

409. Magnetometric map, Kaministikwia, Thunder Bay district, Ontario—by A. H. A. Robinson, 1914-15.

410. Geological map, Kaministikwia, Thunder Bay district, Ontario—by A. H. A. Robinson, 1914-15.

416. Magnetometric map, Matawin Iron Range, Thunder Bay district, Ontario—by A. H. A. Robinson, 1914-15.

Address all communications to—

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SUSSEX STREET, OTTAWA.

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